THE BULLETIN
OF THE
AMERICAN CERAMIC SOCIETY

A MONTHLY PUBLICATION DEVOTED
TO THE PROMOTION OF CERAMIC
EDUCATION AND TECHNOLOGY

JUNE • 1934

VOLUME 13 NUMBER 6

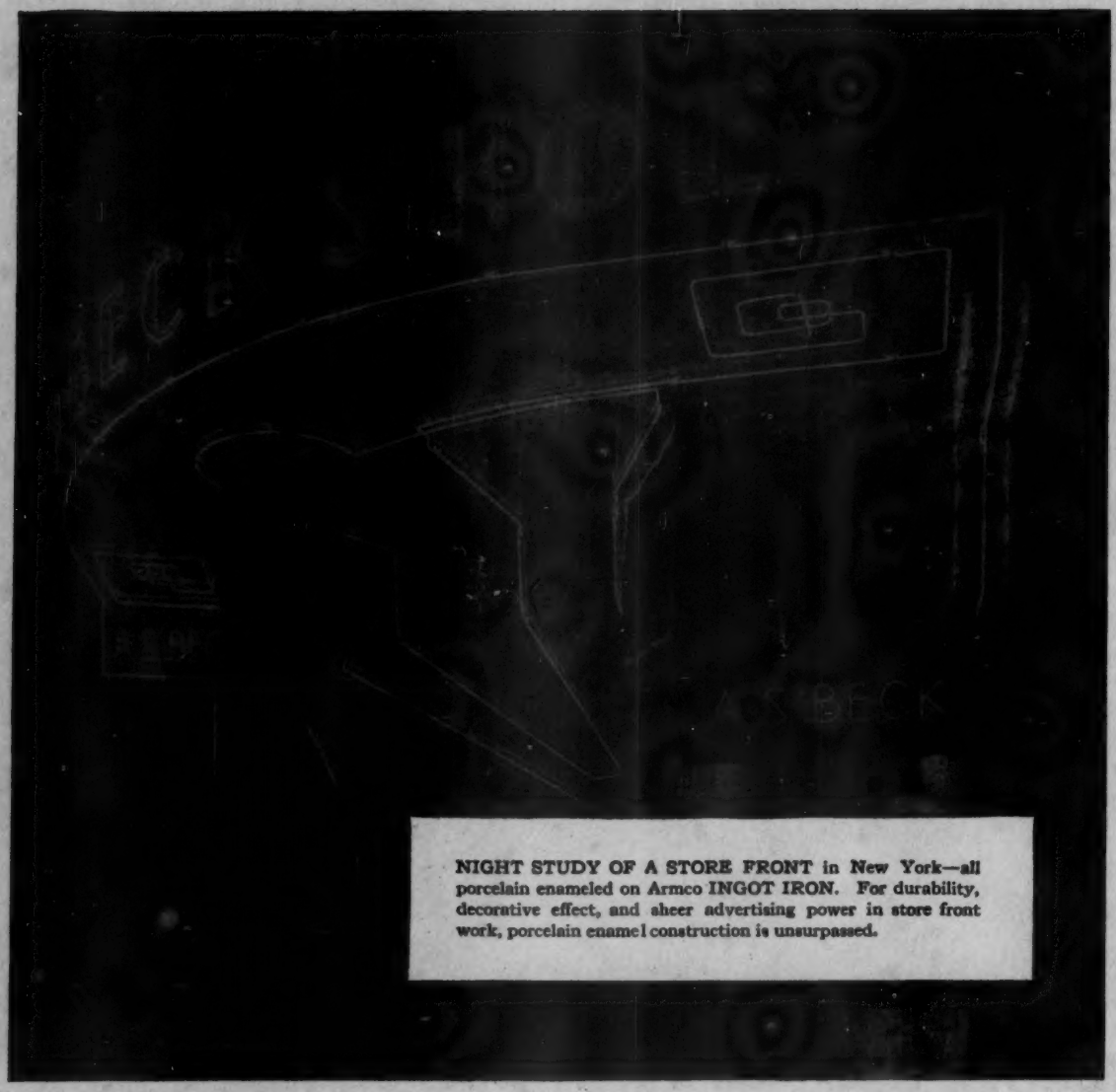

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Table of Contents

VOLUME 13 JUNE, 1934 NUMBER 6

Editorials 145

American *vs.* European Tableware—By Arthur S. Watts 153
Ceramic Education: A Discussion—By F. H. Norton 150
Comments on Ceramic Education—By J. L. Carruthers 146
Greater Production Economy and Better Ware Quality Suggestions 151
The Edward Orton, Jr., Ceramic Foundation 145

Papers and Discussions 154

Reasons for the Use of Auxiliary Fluxes in Whiteware Bodies—By Arthur S. Watts 162
Water-Tight Terra Cotta Construction—By Eckardt V. Eskesen 154

Activities of the Society 164

American Ceramic Society Urges Adequate Support for the Bureau of Standards 168
Baltimore-Washington Section Hears Frederick Brackett—By Clarence Hahner 167
California Section Meets 167
Ceramic Education: Letters to the Editor 169
Chicago Section Active in Illinois 167
Conference on Glass Problems Held June 1 167
Corporations Pay Minimum Fee 170
Local Section News 167
Necrology: Arthur D. Forst 171
New Members and Roster Changes 168
Pacific Northwest Section Elects New Officers—By Hewitt Wilson 168
Pittsburgh Section Hears A. Nadai 168
Resolutions 168
Shuffle Off to Buffalo 164
Summer Pottery Courses at West Virginia University 168
Symposium on Kiln Firing Proposed 165

Notes and News 171

Current Ceramic Literature 174
Edward Orton, Jr., Ceramic Foundation 171
Errata 174
June Meetings 173
New Abstracts of Silicate Literature—By Selik I. Perkal 174
News of Members 172
Silicosis Bibliography Issued June 10 174
37th Annual Meeting of the A.S.T.M. to be Held June 25 to 29 173

Advertisers' Index 13

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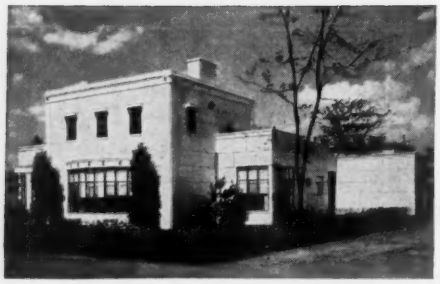
Editorial and Advertising Offices: 2525 N. High St., Columbus, Ohio.
Executive Office: 2525 N. High St., Columbus, Ohio.
Committee on Publications: L. NAVIAS, *Chairman;* L. J. TROSTEL, M. F. BEECHER, R. M. KING, ROSS C. PURDY

Entered as second-class matter at the post office at Easton, Pa., under the Act of March 3, 1879
(Copyright 1934, American Ceramic Society)
Subscription $1.50 a year. Single numbers twenty-five cents
(Foreign and Canadian postage, 50c additional on subscriptions)



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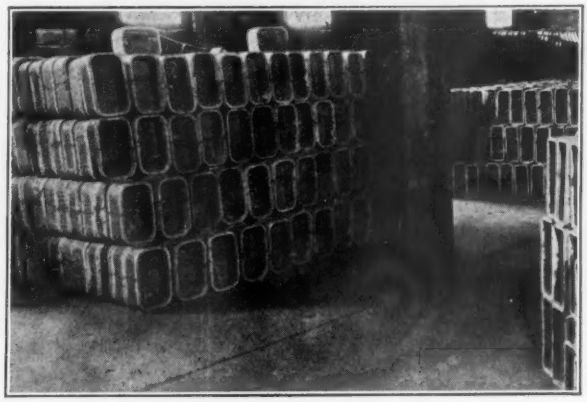

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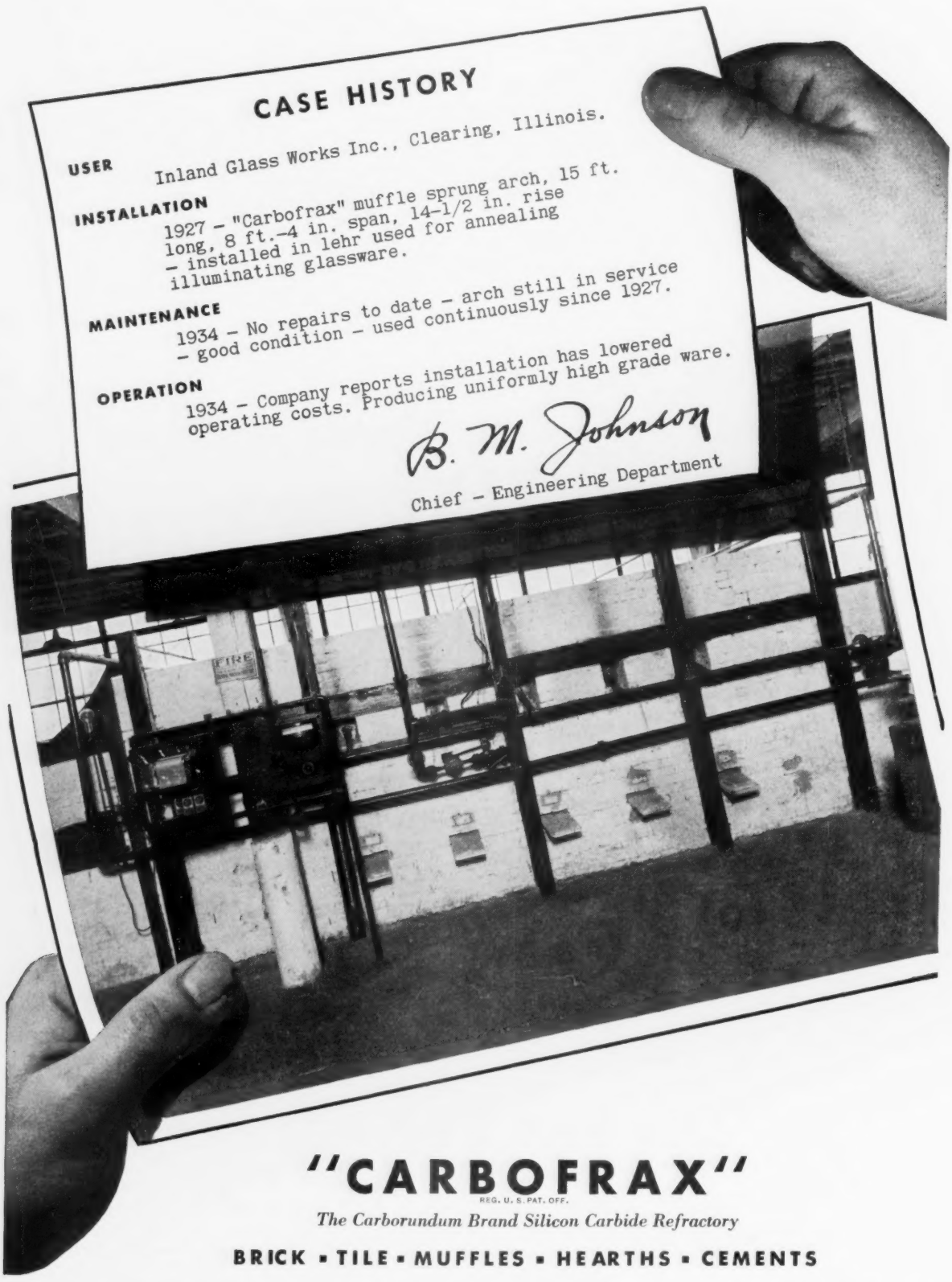
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THE BULLETIN

of the American Ceramic Society

A Monthly Publication Devoted to Proceedings
of the Society and Promotion of Coöperative Research
of Technical, Scientific, and Art Questions

Vol. 13 JUNE, 1934 No. 6

EDITORIALS

THE EDWARD ORTON, JR., CERAMIC FOUNDATION

On February 10, 1932, General Edward Orton, Jr., founder of collegiate ceramic education in America and organizer of the American Ceramic Society, passed from life unto immortality. Notable while living for his achievements in many activities, the working monuments which he left will continue to add to his renown. Collegiate ceramic schools, the American Ceramic Society, the Ohio Geological Survey, the Ohio State Engineering Experiment Station, the National Defense Act, the Reserve Officers Association, the Columbus Gallery of Fine Arts, Camp Mary Orton for under-developed children, and the Orton Geological Library are some of these working monuments. Mt. Orton stands in Estes Park as mute testimony of the wide range of General Orton's activities.

One other working monument he left to ceramic posterity, The Edward Orton, Jr., Ceramic Foundation. The purposes of the Foundation are two: (1) to continue the production of Standard Pyrometric Cones of maximum dependability as a means of measuring ceramic ware heat treatment, and (2) to prosecute researches of importance to the ceramic arts and sciences. The broadgage manner in which he planned for this Ceramic Foundation was set forth in the memorial editorial in the March, 1932, issue of *The Bulletin*.

The obtaining and holding of the highest possible standard in quality of pyrometric cones produced and the finding of compositions, shapes, and methods of processing them so that they will most accurately measure ceramic-ware heat treatment were his first considerations. General ceramic researches were to him of secondary importance.

In his own words:

> There are two purposes for which this trust is created. The first and principal purpose is to provide a stable and dependable organization for continuing the manufacture and sale of Standard Pyrometric Cones of the highest quality and most exact accuracy that is commercially feasible at a reasonable price. The second and subsidiary purpose of this trust is to provide a Research Organization for the prosecution of studies and researches for overcoming technical and manufacturing difficulties, and for thus advancing the ceramic arts and industries of the United States. . . .
>
> I entered the manufacture and sale of pyrometric cones with the purpose of performing a definite and needed service to the ceramic industries: (1) by enabling them to better control the firing of their products, which is the weakest point of the manufacturing process; (2) by facilitating the freer exchange of exact information concerning the firing process between ceramic manufacturers; and (3) thus inducing a better and more coöperative relationship among them, and thus making greater scientific and industrial progress probable. In this enterprise, while manufacturing profit is essential to permit its continuance, it has, from the first, been my purpose to make financial profit incidental to the principal idea of furnishing to ceramic manufacturers a mode of controlling or regulating the firing process of their ware with the highest attainable degree of dependability at the lowest reasonable cost. Having been successful in obtaining the confidence of manufacturers of ceramic products in Standard Pyrometric Cones, it is my desire to assure myself that the manufacturing establishment which I have built up shall continue to fulfill this same useful purpose, upon the same high plane, and with the same ideals of public service after my death.

General Orton passed away while he was financing these several monumental projects including the new Standard Pyrometric Cone Laboratory. It has taken his administrators and the Probate Court two years to work out the financing of the several projects which General Orton started. The Court instructed Mrs. Orton and her co-administrator to continue the Standard Pyrometric Cone Company under their own direction until final arrangements for these several projects were made. On January 1, 1934, by court authorization, the Standard Pyrometric Cone Company was transferred to the Trustees of the Edward Orton Ceramic Foundation to administer as prescribed in General Orton's will.

The Board of Trustees as named by General Orton consists of seven members, the president of the Ohio State University, a representative of the National Bureau of Standards, Director of Ohio State University Engineering Experiment Station, Head of the Department of Ceramics, Ohio State University, Secretary of the American Ceramic Society, member appointed by the Board of Trustees of the American Ceramic Society, and one reputable attorney appointed by the Probate Court of Franklin County, Ohio.

In this manner did General Edward Orton, Jr., plan the continuance of the research in and the manufacture of Standard Pyrometric Cones of such quality and nature as will best measure ceramic-ware heat treatment and enable the most reliable control of the firing of ceramic products at the lowest possible cost. This, the Trustees of the Edward Orton, Jr., Ceramic Foundation are intent on accomplishing.

To this end they will have available the informational and research facilities of the Ohio State University, the National Bureau of Standards, and the American Ceramic Society. In the promises given by these contacts through representation on the Board of Trustees, the ceramic industries may rest assured that the most adequate and the best possible heat treatment measuring devices will be provided.

COMMENTS ON CERAMIC EDUCATION*

I. Introduction

In the editorials on ceramic education and the letter to the Board of Visitors of the Ohio State University[1] so many questions were raised and inferences made, especially in regard to the ceramic engineering curriculum and methods of teaching at Ohio State University, that the editorials should not go unanswered.

We do not question the rights of the American Ceramic Society to investigate, study, or advise on ceramic engineering training. However, we do question many points and inferences in the editorials since they are based entirely on personal opinions of the Editor and not on findings of the Education Committee of the Society.

The purpose of the following statements is (1) to refute several allegations made in the editorials, (2) to question the philosophy of the Editor, and (3) to present our position on ceramic education. They are based on surveys and data accumulated by the staff of the Department of Ceramic Engineering of Ohio State University.

II. Qualifications of Ohio State Staff to Discuss Ceramic Education

It is our belief that we are as close to and have as clear an understanding of the needs, problems, and advances of various ceramic industries as any agency in the country, not excepting the headquarters of the American Ceramic Society, and therefore are not biased in our point of view on ceramic education. This belief is based on the following facts: (*a*) all members of the staff have been employed at some time in the industry and are still maintaining contacts; (*b*) requests for aid and advice on technical problems, developments, and research are continually coming from the industry to the members of the staff; (*c*) engineers and executives from the industry are constantly bringing in the latest information on new developments and research in ceramics; (*d*) staff members are continually serving on various committees of the American Ceramic Society, trade associations, etc.; (*e*) staff members are contributors to and followers of all technical and trade journals; (*f*) every few years a survey is made to check up on the educational requirements for men going into industry; (*g*) considerable research is conducted on problems sent in by industry.

III. Discussion of Various Points in the Editorials

(1) Substitution of Cultural Courses, etc. The statement was made that the Curriculum Committee of the Engineering College of Ohio State University was considering the substitution of cultural courses in part for mathematics and chemistry. Such is not the case. The writer has been an active member of this committee since its organization and hence is qualified to know just what is being done. The

* By J. L. Carruthers, Department of Ceramic Engineering, Ohio State University, Columbus, Ohio. Received April 11, 1934.

[1] *The Bulletin*, pp. 2–4 (Jan., 1934); pp. 31–33 (Feb., 1934).

committee is studying the amount of time allotted in the Ohio State engineering curricula to mathematics, freshman chemistry, and drawing. Data show that considerably more hours are being given to these subjects than at most schools. There is no question regarding the importance of these fundamental subjects in the training of an engineer.

Various educators, engineering educational societies, technical societies, and many employers of graduates are recommending that the engineering schools include in the curricula such subjects as economics, political science, sociology, history, English, accounting, etc., in addition to thorough training in the fundamentals of engineering, in order that the graduate may be better equipped to advance in industry and to serve as a citizen of his community. Such recommendations are being considered by the committee and the individual engineering departments. Several departments have included courses in economics and history in their curricula, but only at the expense of applied engineering subjects. It is felt, however, that until five-year curricula are established, very little can be done along this line. The committee is studying the possibilities of the junior college and the five-year curriculum.

The above points, however, are all incidental to the general problem, *viz.*, to devise a program that will prepare the engineering graduate in the best manner possible in the time allotted to meet the needs of industry and citizenship. The needs of industry must be considered from the standpoint of general or average demands.

(2) Teaching of Fundamental Sciences The implication is made that fundamental science courses are being taught by the applied science departments. This is not true in the ceramic curriculum at Ohio State University with one possible exception, *viz.*, quantitative chemistry, which is taught in the metallurgy department. This is justified by the personnel and equipment of that department and their close contact with the ceramic industry.

It should be remembered that engineering is primarily the application of the fundamentals of science. Consequently, each engineering department finds that it must review, enlarge on, and apply the fundamentals of physics, chemistry, mineralogy, geology, etc., that its students have been taught if they are to be thoroughly trained in engineering subjects. Obviously this can not be done in a general science department unless they set up specialized courses.

An analysis of the type of work followed by ceramic engineers indicates that (*a*) a small percentage of graduates, mainly in research work, would have benefited by additional training in the fundamental sciences, and (*b*) the remainder have ample training in such subjects and are not being held back by lack of additional training in the sciences. In many cases the engineering graduates are in or are working toward those phases of industrial activity where but a small part of their work is of a technical or scientific nature.

(3) Leadership in Ceramics The statements made in the editorials in regard to the attainments of ceramic graduates as scientific and technical leaders in the promotion of the industry are quite misleading when conditions are carefully analyzed. As a matter of fact, full data would indicate that the record of graduates from ceramic schools is of considerable merit.

Election to the presidency of the American Ceramic Society, membership on the Society's committees, and appearance on the programs of the Society can not be used as a measuring stick for the character and quality of ceramic education because of the scope of the American Ceramic Society and the industrial pursuits of ceramic graduates. The American Ceramic Society does not confine its membership list to scientific and technical men. It is made up of scientists, engineers, artists, executives, superintendents, foremen, salesmen, and others interested in ceramics.

It is apparent, or should be, that election or appointment to the various offices of the American Ceramic Society is based on interest and activity in the functions of the Society, its policies, and, in some cases perhaps, politics. The ceramic schools and their graduates are faithful supporters of the activities of the Society regardless of the way offices are distributed.

A considerable number of the graduates of the ceramic schools have advanced to responsible executive positions in the industry. Others are working toward that end. In most cases, these men are no longer in a position to make technical contributions to the Society. If the interest of these men in the work of the Society has not been maintained, it is the fault of the individual, his employment conditions, or the Society itself and not their ceramic training. Men in this class have

been successful because of their own personal characteristics, education, and opportunities; hence they are leaders in industry.

Other ceramic engineers are rendering service to industry through the control and development of materials, product, and process. In many cases the findings in their work and research can not be published because of its value to their employers. When such men are permitted to publish the results of their work it is because the management believes it will be to their interest to have such information broadcast or that it has no commercial value, but is of general interest.

The fact that a considerable number of papers on fundamental research problems are presented by men trained primarily in physics and chemistry can not be used to judge ceramic engineering education and leadership of ceramic school graduates. A brief review of the history and purpose of ceramic engineering education will bear out this statement.

Up to 1929 only a few ceramic graduates pursued graduate work. This type of training is now recognized as essential for any one who expects to do fundamental scientific research. Previously, the rewards of industry seemed to be too great for the engineering graduate to spend an additional one, two, or three years for advanced training. Some who were capable of doing creditable scientific work and wished to obtain additional training could not do so because of financial problems. Others were not encouraged to do so because of their limitations. Consequently, there has been a lack of ceramic engineers having that additional *advanced* training in the sciences that would permit them to qualify for much of the research now under way.

The ceramic department at Ohio State University has been primarily concerned with the training of engineers, not scientists or technologists. This was due to the demands of industry for men with engineering training. It might be noted, however, that during the last few years a considerable number of graduates are seeking the Master's and Doctor's degree due to economic conditions and an increasing demand for ceramic engineers with advanced training.

Data of the following character should be obtained and published so that a true perspective may be had:

(1) Total membership of the Society.
(2) Per cent membership in the Society of graduate ceramic engineers.
(3) Per cent membership in the Society of men trained in physics and chemistry.
(4) Per cent membership in the Society of men with advanced degrees.
(5) Total number graduated from ceramic schools.
(6) Number of ceramic graduates remaining in the industry.

The first four items could be obtained from the Society's files, and the various ceramic departments could furnish the last two.

(4) Teaching Methods The opinions of the Editor as to the methods of teaching ceramic engineering and technology and the work to be given are not in agreement with the results of the department's survey of its graduates who are making a success in industry. The "known" material in the literature which the Editor claims will be picked up by the graduate in industry is confined principally to practical information. The "boiling down," correlation, and interpretation of the great mass of technical and scientific material for the use of the engineer is one of the functions of teachers in an engineering school and is not readily done by the average college graduate. It must be remembered that a considerable amount of "culling" must be given to the material published in the literature. New material must be checked and proved before it can be accepted as "gospel." The knowledge of the basic fundamentals of ceramic technology can not be easily acquired when one is working in industry where "rule-of-thumb" methods are often used.

There are a number of papers published in the literature reporting the results of workers with scientific training who are attempting to solve ceramic problems. These workers quite often come to conclusions that either are quite evident to men with ceramic school training or have no real value from an engineering standpoint. It is apparent that in many cases the researcher had not acquired the fundamental information that the Editor claims will come from reading and industrial contact.

The Editor apparently has no complaint to make with the teaching of physics, chemistry, mathematics, mineralogy, geology, etc., by the lecture, recitation, reading, and laboratory method, but, according to him, the teaching of applied sciences to students that have not acquired the fundamentals of ceramics should be confined to laboratory courses on original problems. This

method might be satisfactory if sufficient time, equipment, and funds were available. Experience indicates, however, that much of the fundamental data should be given by lecture or text, supplemented by demonstration of the principles in laboratory problems of a research type. The practical information taught a decade or more ago to which the Editor refers is no longer taught where the fundamentals of ceramic science have been developed. The methods used are to make the students acquainted with the fundamentals of ceramics as developed through research and industrial usage, to show the application of the fundamentals, and then to make the student think and reason on new problems in terms of fundamentals. We believe that if we can produce an engineer who can and will think in terms of fundamentals he will go far if he is at all interested in his profession.

(5) Ceramic Education The conclusion should not be drawn, in view of the foregoing discussion, that the Ceramic Engineering Department at Ohio State believes that its methods or course content are perfect. Every year its offerings and the curricula, as a whole, are reviewed and when changes are indicated they are made.

Our problem, which is familiar to every manufacturer, is to produce an article for which there is the greatest demand. The demands from industry are principally for engineers, with only a limited demand for highly trained technologists. The engineering group can be fairly well equipped in four years' time. The technologists, however, must be developed from those students with a mentality, scholarship rating, and bent for research that will justify their pursuing graduate work.

We are able to meet industry's demands for engineers and technologists with our present curriculum in ceramic engineering plus graduate training. The senior year program provides for a number of elective subjects and optional work in the ceramic laboratories. By the time the student has reached this stage of his course, he has somewhat definite ideas as to the type of work he wishes to follow, and the department has become thoroughly acquainted with the ability, qualifications, and ambitions of each student. Then through conferences with the student we are able to suggest certain elective courses that will tend to round out his educational equipment or prepare him for graduate work. Some students are advised to take cultural courses, others economics, management, and business courses, and others to take work in advanced fundamental sciences or engineering. The flexibility of a course of this type permits us to recognize and provide for the varying needs of the individual and industrial requirements.

(6) Suggestion If the subject of ceramic education is to be a real problem for the American Ceramic Society to consider, a definite organized study of the subject should be started. Sporadic committee work once a year results only in a certain amount of wrangling over the ideas of those individuals who desire to express their thoughts. Reliable data from industry, ceramic graduates, schools, and others on the subject of education could be obtained by a survey and then studied by a competent committee. The conclusions of such a committee would be of value and their recommendations to the schools would have real merit.

Until such a study is made, all discussion of ceramic education should be presented to the Committee on Education of the American Ceramic Society for its consideration. If the committee believes that material presented can constructively aid in solving the problem it should be approved for publication.

IV. Conclusion

The Ceramic Department of Ohio State University believes that the statements made in the editorials in regard to men with ceramic engineering training are quite unfair in that they tend to discredit these men with their employers, present and prospective. Their training, ability, and achievements must have been worth while, otherwise industry would not have retained them, advanced them, and asked for additional men with similar training.

The attack on the ceramic schools was not warranted. The meager data presented were interpreted only in the way in which it would suit the purposes of the Editor.

It is our belief that ceramic schools in general are fully aware of the problems of industry and that they are at all times interested in receiving constructive criticism regarding curricula, course content, and methods of teaching. Each ceramic school, within the limitations under which it must

operate, is endeavoring to provide the best collegiate training possible for its students so that they may be of real service to industry and make real progress in the pursuit of their careers.

It is somewhat evident that all persons are not discussing the same type of ceramic education. It must be recognized that ceramic engineering and ceramic technology or science are two fields of endeavor that are related but yet different in the training that should be provided, the type of man needed, and the type of work that is to be followed. The technologist must have graduate training if he is to be at all valuable. There is room and need for both the engineer and the scientist in industry and the education of both must be considered.

CERAMIC EDUCATION*

I have been following with considerable interest the recent discussion on ceramic education which has been published in the *Bulletin of the American Ceramic Society* and in other ceramic journals. It would seem that the discussion comes down to a struggle between the fundamentalist and the technician. It is quite possible that both sides of this question may be right, because it should be the purpose of the ceramic school to educate and train men who will be most useful to the industry; and it would seem quite reasonable to assume that industry needs men of both types from the ceramic schools.

If we analyze the needs of the ceramic industry a little more closely it will be found that in general three types of men, rather than two, are required. First, a considerable proportion of men having the trade-school type of training is needed for strictly routine and control work in the plant. This type of man should have had some practical experience, but many plant executives have found that higher education is not a requisite, for he must be willing to follow instructions exactly and not be irked by a repetition of routine duties.

Men of the second class are those employed in research and development of new processes, and the main part of their time is spent in correcting the defects which show up in the finished ware and in reducing the production costs. This class is usually derived from the better men who have begun work in the first class, although many are taken directly from the colleges. This type of man should undoubtedly have a good fundamental training in ceramics, but he should also have, as far as possible, a practical working knowledge of the various processes used. Many plant executives feel, however, that if only four years can be spent in college a graduate in physics or chemistry has a better foundation than the graduate from some of the ceramic courses.

Men of the third class needed by the industry are those who are going to be the leaders in their field. They are the men who will devise new products, find new uses for the present products, develop new policies of merchandising, and have sufficient artistic ability to talk intelligently with the architects and buyers. This type of man certainly needs the most fundamental training in physics, chemistry, and petrography as well as in the fundamental ceramic processes. He should have some understanding of the historical side of ceramics and should at least appreciate the artistic point of view. He should also have a reading knowledge of French and German in order that he may keep himself informed of the latest developments abroad and not have to pick up second-hand scraps from those who can read these languages. Economics and business principles should not be neglected. Such a type of man probably can not be trained in four years.

Industry needs more of the latter type of man than it realizes in order to keep abreast of the times. The ceramic industry is, of course, a very old one, and following the general principle that the older industries are less liable to adapt themselves to changing conditions than the younger industries, this industry is carried on now in much the same way that it was operated several hundred years ago. An interesting example of this has just come to my attention in looking over the excellent reproduction of the Italian manuscript, Arte del Vasaio, by Cipriano Piccolpasso† which was written in the early part of the sixteenth century. It is indeed surprising how similar

* A discussion by F. H. Norton, Massachusetts Institute of Technology, Cambridge, Mass. Received May 5, 1934.

† See this issue, p. 174.

were the manufacturing processes used by the Italian majolica potters to the processes used in many of our present potteries.

As an example of the need for thoroughly trained men, let us consider the tile industry. It is surprising that it has allowed itself to be handicapped by the troublesome crazing of glazed tile. It is beyond question that noncrazing tile can be made, but there are few tile installations that have been in position any length of time that do not show crazing in a considerable number of the tile. Tile of light color soon become very unsightly, and this difficulty has undoubtedly been the cause of the substitution of other materials for tile. Here is a case where the industry as a whole has been willing to go along producing an article which it knew was likely to cause trouble, and which could have been made satisfactory with little or no increase in manufacturing cost. All that was required was a thorough knowledge of the principles involved and a more careful control of the manufacturing process. Modern demands for color have brought on the market a great many tile having a colored glaze. In this field there have been many complaints from the discriminating consumer concerning the poor control of the color; that is, a particular shade would vary so from lot to lot that it was difficult to install a satisfactory job, and the color variation was considerable in a single piece, especially in cap and base tile. Here the industry needs men who, in the first place, realize the economic importance of eliminating these defects and at the same time have the fundamental understanding and the perseverance to correct them.

As another example, consider the field for face brick. This industry has lost millions of dollars worth of business because so many leaky brick walls have been installed. The industry needs men who will appreciate the importance to their business of making brick walls free from this defect. This is by no means an impossibility because many brick walls are tight, and a little intelligent study of the problem would most certainly correct the trouble.‡ This industry has also lost a great deal of business from efflorescence on brick walls, which in many cases is so unsightly as to deter the architects from chancing the use of this material. While at the present time we do not thoroughly understand the cause and cure of this trouble, there are many brick walls which are entirely free from efflorescence, and it would not seem to be an impossible task to find the cause and the cure. Here again the industry needs technical men with enough vision to see these problems in their broad aspects and to solve them before other types of material have made serious inroads on the prospective market.

We can not help contrasting the inertia of these older industries to changing and improving their product with the activity of the younger industries, which are always looking ahead and adapting their product quickly to the demands of the consumer. Can this difference be laid at the door of the technical training courses?

This leads up to the question of whether or not the ceramic schools in general are turning out too large a proportion of sink chemists and screen tappers. It is my opinion that the ceramic industry requires more of the soundly trained men than the ceramic schools turn out, and that in the past it has had to take outstanding men trained in subjects like chemistry and physics because it could not get what it wanted from the ceramic schools.

‡ See this issue, p. 154.

GREATER PRODUCTION ECONOMY AND BETTER WARE QUALITY SUGGESTIONS

The firing of ceramic ware, clay, glass, and vitreous enamel, is not only a large item in production costs, but from the standpoint of ware quality it is also a crucial factor. A very incomplete survey, instigated by the Research Committee of the American Ceramic Society, of kiln firing in plants making brick showed the possibilities of large savings in fuel.

The sums being spent by ceramic industries on electric kiln development and on surface combustion means of kiln and furnace heating warrant a thorough study of the possible economies and product qualities obtained.

The Materials and Equipment Division will have one general meeting symposium on this subject at the 1935 Annual Meeting of the American Ceramic Society in Hotel Statler, Buffalo, New York, Monday afternoon, February 18. In

anticipation of this meeting, the Research Committee will seek data, promote investigations, possibly plan researches in universities and plants, and collaborate with interested fuel, equipment, and kiln companies and associations.

(1) Method of Heating Heating is done by convection, conduction, and radiation. Equal heat distribution is obtained when each of these means of heating is, in all parts, as effective as in any part of the kiln, oven, tank, or furnace.

Convection is the transfer of heat by means of currents in the gases resulting from the combustion process or by mechanical means.

Conduction is the transmission of heat from one body to another in contact or from one solid particle to another solid particle.

Radiation is the emission and diffusion of heat rays due to difference in temperature.

(2) Importance of Uniform Thermal History To obtain uniform quality of ware, piece after piece, or to obtain uniform qualities throughout a given piece of ware, such as is so vitally necessary in glassware, grinding wheels, high-tension insulators, and in ware that is to be subjected to mechanical, electrical, and thermal stresses, the whole kiln setting must have the same equal thermal treatment in time of exposure, manner of exposure, and temperature intensity. Furthermore this thermal treatment must be given as slowly as is necessary to permit the heat to penetrate uniformly through the structure of each piece. Gradually we are learning that each ceramic ware must have a constant and uniform thermal treatment if it is to be guaranteed to meet exacting service specifications.

(3) Convection Is it a demonstrated fact that uniform thermal history for ceramic ware can not be obtained by convection as the only means of transfer of heat from the heat source to the ware? Is this why electric heating of kilns has so miserably failed? Is this why dependence on complete combustion of solid or gaseous fuels in the fire box or at the burner and convecting the heat to the ware has failed? Is surface combustion as a heat source applicable to kilns or to furnaces where equal thermal history is required throughout a given piece of ware and from piece to piece?

Of course such heat as is generated at the source and the heat generated by combustion of gases *en route* to the ware must be taken care of by a controlled movement of the heated products of combustion, *i.e.*, by convection. Experience, however, has shown that this can not be forced or be turbulent in character if the ware is to be given a uniform thermal history.

(4) Conduction Conduction is a minor means of heat conveyance from the heat source to the ware, but a very important means of equalizing the heat throughout a given piece. The heaviest luminosity in gas flames originating from gas or coal is due to less than 1% of the total carbon in the gas. There is very little fly ash. Certainly from neither of these solids can there be much heat conduction from flame to ware.

(5) Radiation Radiation plays an important part in ceramic-ware heating, but has dependence on radiation for heat conduction from the heat source to the ware, as in muffle kilns, been successful in securing for the ware a uniform thermal treatment?

(6) How to Obtain Uniform Thermal Treatment How then can uniform thermal treatment be given to a stack of ware in periodic or in tunnel kilns? The only answer to this question is based on experience. Can it be given alone by hot gas streams, convection? Is conduction a factor? Has dependence altogether on radiation, as in muffles, failed?

Is it not true that uniform distribution of heat throughout a kiln and the giving to each piece of ware the same thermal treatment throughout its structure can be obtained only by the burning around each piece in the kiln of the carbon monoxide and hydrogen which result from gases generated from coal or from the cracking of the gaseous hydrocarbons fed through gas burners? And is it not true that this sort of equal heat treatment and uniform thermal history can be obtained by using as primary air only that which is required to produce carbon monoxide and hydrogen and supplying as secondary air that which is required to complete the combustion of the carbon monoxide, the small amount of free carbon, and the hydrogen, plus a slight excess? This is known as diffusion combustion.

Is it not by observance of these elementary principles that maximum heating economy and greatest uniformity in ware can be obtained? These are the questions that will be discussed in the above-mentioned Symposium on kiln firing at our 1935 Annual Meeting in Buffalo.

AMERICAN VS. EUROPEAN TABLEWARE*

By Arthur S. Watts

The American purchaser is constantly confronted with sales arguments in favor of European tableware, including superior translucency, workmanship, glaze, decoration, and general durability. These arguments are presented not only for the porcelains of continental Europe but for English china and for the earthenware of both England and continental Europe.

In addressing various group meetings during the past several years on "Tableware for the Home," I have found the audiences either grossly ignorant or definitely prejudiced against American tableware.

During the past year I have contacted numerous hotels and restaurants on the subject of tableware and have been surprised to find many buyers who recognize no superiority in American hotel chinas.

I am convinced that the public is interested and that a properly organized exhibit in our leading cities would yield excellent returns on the investment. Results can never be secured from showings in stores where tableware is sold, however, and must be organized on entirely different lines.

In connection with such an exhibit, the American tableware manufacturers should also present conclusive evidence that the foreign ware is in no way superior as to utility. This calls for an organized research, in which all prominent brands of European tableware and at least an equal number of American brands should be studied by an entirely disinterested party. Every test must be carefully designed to simulate service and made on such a scale that the results can not be questioned. The study must include the body, the glaze, and the decorations, each considered separately.

The essential information is possessed on which to develop tests which will prove conclusively the service value of each brand of ware. The tests in detail should be studied and developed by a committee made up of producers, consumers, and disinterested technologists. The study of the bodies should be conducted on specimens of the same shape and thickness of rim. The tests should include porosity, water absorption, impact resistance, and translucency. The tests on glaze should include resistance to attack by acid and alkaline solutions, abrasion, and crazing both by impact, temperature shock, and autoclave. The tests on decorations, which would be confined to overglaze decorations, should include resistance to such solutions as would be found in foods and also to soaps and cleaning solutions such as might be used in a kitchen. These tests must recognize the conditions of service and include the alternate exposure to different corroding agents as well as the alternate exposure to such solutions and to abrasion. All of these tests must be interpreted in terms that would simulate time of service of the ware.

The cost of such a research would be surprisingly small, if conducted on a fellowship basis with adequate and competent supervision. If the evidence was unfavorable in some respect, a separate research could be developed to study the problem, but certainly we can not hope to combat this foreign propaganda successfully unless we know the facts.

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* Presented at the Annual Meeting, American Ceramic Society, Cincinnati, Ohio, February, 1934 (White Wares Division). Received February 15, 1934.

PAPERS AND DISCUSSIONS

WATER-TIGHT TERRA COTTA CONSTRUCTION*

By Eckardt V. Eskesen

I. Introduction

The subject, "Terra Cotta and its construction in the wall," on which the writer has an accurate and complete knowledge, may also refer indirectly to brick and other ceramic materials used as a facing material for masonry walls in modern and orthodox building construction. The discussion, therefore, will deal with the practical experience of the writer in this field rather than a presentation from the engineering viewpoint.

* Presented at the Annual Meeting, American Ceramic Society, Cincinnati, Ohio, February, 1934 (Terra Cotta Division). Received February 15, 1934.

(1) Leaking Walls So much has been written about "leaking walls," and so many complaints are on file that the problem is recognized as one of the most serious to be dealt with. There is an impression that brick, terra cotta, and similar facing materials used for the exterior of the modern masonry walls absorb water and cause "leaks." This idea is held not alone by the layman, but also by professional architects and engineers. The contrac-

Fig. 1.—Granite entrance; mortar and salts running out of joints; condition is far worse than shown on the picture; most of the joints defective; some have been repaired (Macmillan Hall, Columbia College group).

tor and owner invariably state that it is the material that leaks.

As far as terra cotta is concerned, the writer does not know of any case where water has entered the surface of the terra cotta, penetrating the wall. The exposed vitreous or glazed surface of the terra cotta does not in itself absorb moisture. On the contrary, it is almost impossible to force water through the surface of terra cotta, even by mechanical means (see p. 158).†

Following in the steps of the development and erection of modern buildings of steel and concrete construction, such as the skyscraper, many new problems have developed which have heretofore been ignored. One of the most serious of these problems is that of "leaky walls." Most of the newly erected costly buildings are giving serious trouble due to water penetration through the outside walls, damaging the interior finish, discoloring the exterior, and hastening corrosion of the steel structure, thereby causing damage in many other ways and bringing with it a large expenditure for maintenance and upkeep.

Terra cotta and other exterior ceramic materials, in many cases where the real cause is not immediately found, have been made to take the blame for this condition. *Faulty mortar joints and faulty construction are given only second consideration.*

II. Strict Supervision of Erection

The drawings and details as furnished by the architect for the erection of the buildings are complete; the specifications are never lacking in detail as to the quality, production, and erection of the ceramic material. The material is manufactured and delivered to the building in strict accordance with the specifications. It is at this point, however, that the supervision of the terra cotta producer ends, and also in many cases this is the end of the supervision of the architect and the engineer. The problem of seeing that the mortar joints are solidly filled, that the mortar is of the proper quality as specified, and that the material is assembled correctly and takes up properly with the adjoining material according to the specifications, is, in most cases, left to other persons. The writer feels that if strict and intelligent supervision of the "men and the material" in the erection of terra cotta is given, most of the difficulties now caused by moisture penetration of the walls of modern buildings would be eliminated.

† Any moisture absorbed by the terra cotta must enter from the inside or through adjoining material.

FIG. 2.—Three fine architectural materials defaced by defective joints: granite, terra cotta, and limestone.

III. Water-Tight Terra Cotta Construction

There are many ways in addition to faulty mortar joints by which moisture can find its way into the wall of a modern building, for instance, defective construction, leaky roofs, and faulty flashing. This paper, however, will be confined to a discussion of faulty mortar joints, since these are considered by the author to be the main cause of leaky walls. This subject, too, is closely related to the discussion of water-tight terra cotta construction.

FIG. 3.—Limestone top of colonnade, 4th story; leaks badly through joints; most of them defective and open. This building is of monumental character, fine material used: granite, limestone, and a good quality of brick; mortar or workmanship in setting is bad (Macmillan Hall, Columbia College).

(1) Leaky Mortar Joints Leaky mortar joints have been the subject of much oral and written discussion recently. Many complications have arisen and many investigations have been undertaken by ceramic schools and research laboratories and also by the National Brick Manufacturers Research Foundation in an effort to arrive at a solution of this problem. Serious thought has been given to the discovery of where the fault lies, whether with faulty mortar joints or with the material itself.

A number of contributions on this subject is cited as follows: (1) The Committee on Materials and Methods of the Boston Society of Architects who made an exhaustive study of the subject in 1931 states:

> Most of the troubles of moisture penetration are undoubtedly due to three principal causes: (*a*) lack of cohesion between the masonry units and the mortar, (*b*) shrinkage of the mortar, and (*c*) improper filling of the end joints with mortar between the masonry units.

(2) Frank C. Jamin, C.E., of the Bureau of Structural Consultants writes as follows:

> About 75% of the leaks in masonry occur through the joints. Defacement, chipping, and discoloration of brick, stone, and terra cotta are directly attributable to weathered and defective joints . . . mortar joints as found in many buildings merely serve to keep the brick apart, whereas their true function is to bond the brick together and form a uniformly dense face of masonry.

(3) F. O. Anderegg of the Mellon Institute of Industrial Research states:

> Upon the bricklayer's workmanship, more than upon any other single factor, rests the responsibility for the integrity of the wall.

(4) L. A. Palmer, formerly with the Bureau of Standards, states:

> Neglecting to fill the head joints is the most prevalent cause of moisture transmission.

John H. Malon, cement expert, states that a reasonable observance of the following factors will ensure dry walls: workmanship, design, type of joint, joint, and mortar materials.

The above citations are an indictment of the mortar joints as used at the present time as a bonding of the material. The quality of the mortar itself and the workmanship are blamed for the present trouble with leaky walls. This question becomes much more serious when considering that the present one-half inch mortar joint, now in use on the façade of a brick building, constitutes about 18 to 20% of the entire wall surface.

The erection of the exterior of a modern building is, after all, not the function of any one workman, but rather the assembly of various materials, produced and supervised by specialists.

In the case of terra cotta, the material is delivered to the contractor who either undertakes

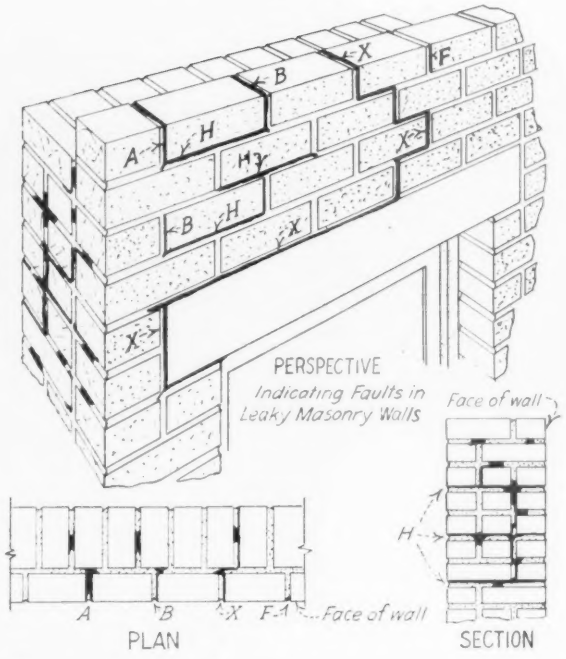


FIG. 4.—*A*, improperly constructed mortar joints. This class includes joints which are too narrow to permit slushing fully and joints which are merely struck from the surface without being filled. The fault is discovered either by sounding with a hammer or chisel or by the unusual amount of liquid which is absorbed. This fault is always corrected by raking out and repointing with waterproof mortar.

B, a joint which has shrunk from the side of the brick or from which the brick has loosened during construction. Almost every vertical joint in the wall presents the possibility of being in this classification. This is the hardest kind of fault to detect. It invariably sounds solid with a hammer or chisel. The opening on the surface may not be apparent.

F appears as a fault, but is an irregularity only. It refuses to absorb under processing, and is revealed as a solid joint requiring no treatment.

H, a fault in a horizontal joint due to day's work, laitance, movement of brick during construction after mortar has set, or shrinkage of mortar. It occurs more often on the upper stories of the building where the wall is not loaded or at the spandrels in steel-bearing construction.

X, a settlement crack which may wind in and out of the brick for several stories.

the erection of the building or sublets the work to the lowest bidder whose major interest is to erect the material within the cost of his bid. Unfortunately, the terra cotta manufacturer does not as a rule erect his own material. If the mortar used is not of the proper quality or not properly mixed, or if sufficient mortar has not been used to fill the joints or to bind the material together, then within a period of time after the elements have started to work, complaints about leaky walls are made and the manufacturer receives the blame.

It is at this time that the waterproofing expert is called in "to fix" the job, a costly and unsatisfactory makeshift which could have been avoided if the work had been done properly in the first place.

IV. Leaks Other Than at Joints

A multitude of cases can be cited where the Federal Seaboard Terra Cotta Corporation has been called in by the architect, owner, or contractor to determine the cause of a leak in a wall of terra cotta furnished by that company or by competitors. In most instances, it is immediately apparent that the fault lies, if not with the mortar joint, with defective construction, such as leaky roofs or shearing or settling of the walls, etc.

Two cases will be cited on buildings recently erected.

(1) Three years ago, on one of the most discussed buildings in the United States, the wall surfaces were built entirely of glazed terra cotta ashlar, approximately forty stories of the building having this material. About a year ago the owners and the contractors advised us that there were indications on the interior walls that the building leaked. In the conference and examina-

FIG. 5.—Building being waterproofed; about 8 years old; trim in cast cement; gilded (American Radiator Building, New York City).

tion that followed no exterior indications of seepage or infiltration inward through the face of the building were to be found. It was decided to cut a hole about two inches square in the face of the building proper at the floor of an offset, approximately twenty stories from the roof. Before the workman could remove his chisel, a stream of water under pressure shot out.

For once the facing material was not blamed. It was perfectly clear that the facing material was functioning as a container, holding a large quantity of water behind it. The source of this water, as far as the writer knows, has not yet been discovered, and it was finally decided to cut permanent vents or slots in the terra cotta facing at the bottom story piers at each offset to drain the interior of the wall and to prevent possible damage to the terra cotta, the structural steel, and the interior of the building.

Infiltration of water into the modern steel or reinforced concrete structure goes far beyond impairing the appearance or damaging the exterior facing materials; it causes corrosion of the structural steel members of the building and resultant deterioration.

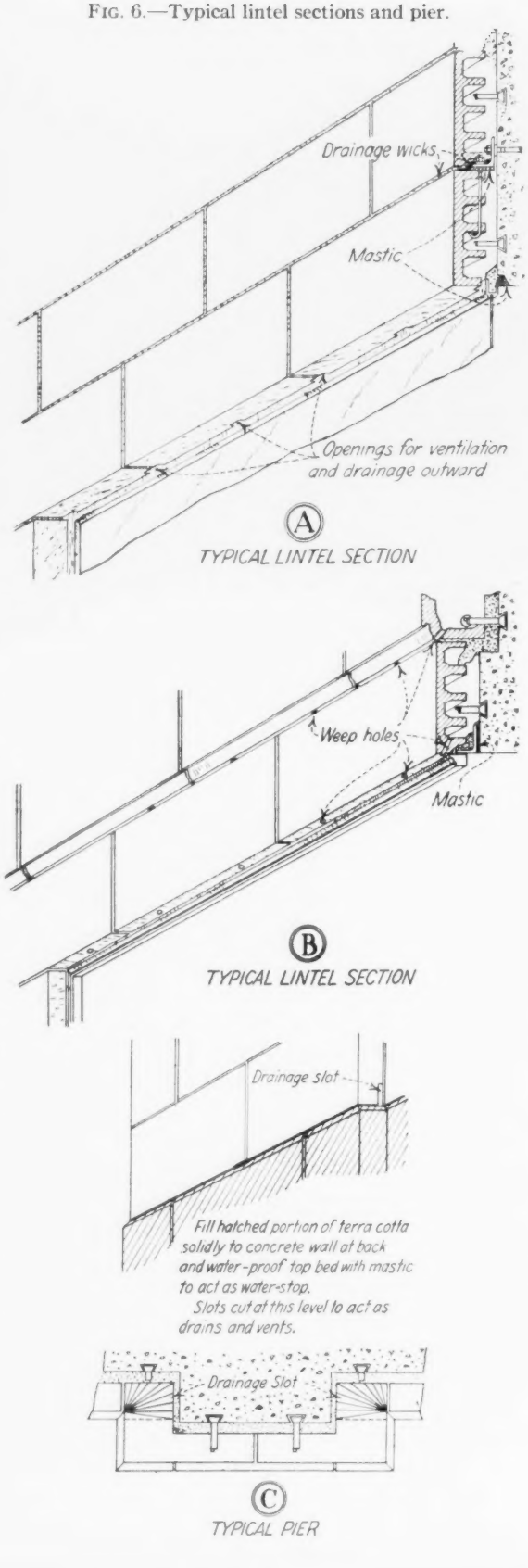
(2) In another instance, the builder claimed that the terra cotta in itself leaked. The terra cotta manufacturer, knowing that the construction was shoddy both as to quality of mortar and the quantity used, requested that a test be made on terra cotta as outlined by L. A. Palmer (at that time research associate, Mortars and Masonry Fellowship of the Bureau of Standards).[1]

Evidently the test was made on this basis. Nothing more was heard from the builder. The terra cotta, incidentally, was a standard unglazed granite terra cotta finish. Glazed terra cotta, obviously, is as resistant to moisture absorption as a bathtub.

V. Lintel Construction

Recently, an architect and a firm of construction engineers, who were thoroughly aware from painful experience of the dangers of water infiltration, determined first, to erect a building as nearly moisture-resistant as possible, and second, to provide means for moisture to be promptly

FIG. 6.—Typical lintel sections and pier.


Drainage wicks
Mastic
Openings for ventilation and drainage outward
A
TYPICAL LINTEL SECTION
Weep holes
Mastic
B
TYPICAL LINTEL SECTION
Drainage slot
Fill hatched portion of terra cotta solidly to concrete wall at back and water-proof top bed with mastic to act as water-stop.
Slots cut at this level to act as drains and vents.
Drainage Slot
C
TYPICAL PIER

[1] L. A. Palmer, "Water Penetration through Brick and Mortar Assemblages," *Ceram. Abs.*, **11** [2], 106 (1932). The article states that a head of $2^1/_4$ inches of water is equivalent to a wind velocity of 62 miles an hour. Similarly, a water head of 5 inches is equivalent to a wind velocity of 93 miles an hour.

FIG. 7.—Limestone; building practically new (Columbia College group, Radcliffe School, 122nd Street west of Broadway, north side).

evacuated if it should penetrate the building from any source. This particular building is entirely faced with terra cotta from the sidewalk to the roof, approximately seven stories, of concrete construction, with shelf angles provided to hang lintels and to prevent shearing stress. Terra cotta experts, in collaboration with their engineers, designed the terra cotta to provide for the evacuation of possible moisture seepage from every source. Condensation was considered one source, and due thought was given to the ventilation of the interior of the wall itself.

Figure 6 illustrates this particular type of construction.

VI. Parapet Walls

It is obvious that there are instances where infiltration of water is caused by defective architectural engineering, causing faulty structural conditions, for instance, at the back of parapet walls, where the roofing material is joined to the wall structure. If defective material is used, leaks will develop within two or three years. This will also happen if good material is used improperly or if no flashing or insufficient flashing is used. The roof becomes a reservoir from which water is distributed into the exterior wall structure.

It seems beyond reason, but it is nevertheless a fact, that on many of the tall costly buildings it is practically impossible to induce the builders or designers to guard their immense investment against contingencies by properly flashing through parapet walls with materials such as copper or lead, a comparatively inexpensive matter. The large producers of limestone recognize and recommend various types of flashing.[2]

VII. Perpetual Building Upkeep

Another point for consideration is the fact that after the building is erected and turned over to the owner, nothing is done to keep it in maintenance and repair. It stands for years at the mercy of the elements without any attention being paid to the protection of its exterior until something serious happens in later years. A costly building investment, like a costly piece of machinery, should receive proper and careful attention during its period of usefulness. The terra cotta industry has given serious thought to all of the difficulties which may arise after the material has been erected in the building in order to try to eliminate later trouble, due either to improper use of the

[2] This subject is well covered in a hand book on copper flashing with detail construction sheets issued by the Copper and Brass Research Association.

The necessity for flashing is also recognized and well covered in the Hand Book on Terra Cotta Construction published by the National Terra Cotta Society.

FIG. 8.—Statue of Bryant, Bryant Park, behind New York Public Library.

material or to its improper erection and construction in the building. Construction experts, after receiving plans and specifications from the architect, check them and make suggestions as to proper construction and layout, always taking into consideration the fact that the materials may be of the best quality but, if not properly erected and protected in the building, they may be subject to damage later on from the elements or other causes.

Among the improvements recently developed in terra cotta construction is the seepage bar joint shown in Fig. 9. This bar is used in horizontal or nearly horizontal wash surfaces, such as parapet coping, sills, or projecting cornice or belt-course members. The entry of water is prevented by interposing in these horizontal joints a strip or bar of noncorroding metal, usually copper or zinc. An undercut groove is formed in each piece of terra cotta wherever such protection seems desirable. In one groove a projecting piece of noncorroding metal is permanently fixed at the factory. When the terra cotta is being set, the entire end and the matching groove in the adjoining piece are solidly filled with mortar, so that when the two pieces are joined the seepage bar is firmly fixed in each, positively spanning and sealing the mortar joints and directing the seepage, if any, to the place where it will do the least damage.

One terra cotta company has abandoned the production of the old-style, deep, rebated joint, particularly because of the depth and mortar capacity of the rebate, since it was found that the mason rarely uses the substantial volume of mortar needed to fill the vertical joint solidly or to provide a full bed joint for the piece above; hence, a flush joint having slight corrugations which require the minimum of mortar, as shown in Fig. 9, was adopted.

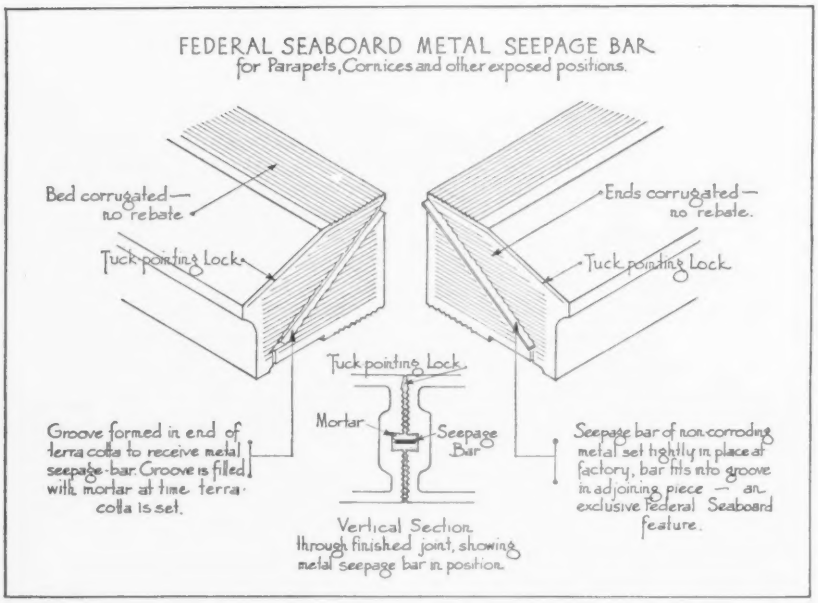

FEDERAL SEABOARD METAL SEEPAGE BAR
for Parapets, Cornices and other exposed positions.
Bed corrugated— no rebate
Tuck-pointing Lock
Ends corrugated— no rebate.
Tuck pointing Lock
Tuck pointing Lock
Groove formed in end of terra cotta to receive metal seepage-bar. Groove is filled with mortar at time terra-cotta is set.
Mortar
Seepage Bar
Seepage bar of non-corroding metal set tightly in place at factory, bar fits into groove in adjoining piece — an exclusive Federal Seaboard feature.
Vertical Section through finished joint, showing metal seepage bar in position.

FIG. 9.—Seepage bar for water-seal joint.

VIII. Mortar Joints of Extruded Terra Cotta

Where extruded terra cotta is used as a facing material, the problem is encountered of forming an adequate surface for solid vertical (end) mortar joints. A mortar joint having only the thickness of the front web of the extruded material is insufficient, a full depth of mortar being required. This problem has been solved by the development of an end surface in the terra cotta, producing a series of indentations easily filled with mortar for the full depth of the piece and forming a positive tight clinched or locked mortar joint when completed (see Fig. 11).

IX. Conclusions

Based upon the assumption that the terra cotta employed as a building facing is made to standard specifications and is commercially sound, both as to ceramic surface and structure, and leaving out of the discussion the factors which produce faults in masonry construction, such as settlement, shearing, or openings caused by expansion or contraction of the wall or insufficient or improperly designed structural steel support, flashing at roof connection, defective drains, or other obviously structural faults, and treating the subject as a practical matter, giving consideration to the data by authorities previously quoted, the factors controlling water-tight terra cotta construction may be summarized and reduced to control of the following factors in the order named:

(1) Workmanship: insufficient mortar, leaving unfilled head and bed joints; mortar joints not struck.

(2) Mortar materials: incorrect proportioning and sizing of component parts (often deliberately for reasons of economy); defective mechanical or manual mixing.

(3) Joint size: later years have seen development of excessively wide mortar joints.

(4) Design of joint: for weathering quality, consideration should be given to the type of joint which will weather best: flat, weathered, half-round, or raked; coloring matter used should be of a type not affecting the inherent quality of the mortar.

The consideration of these factors should give the answer to "water-tight terra cotta construction," and items 1 and 2 can and should be controlled by strict and competent supervision in the

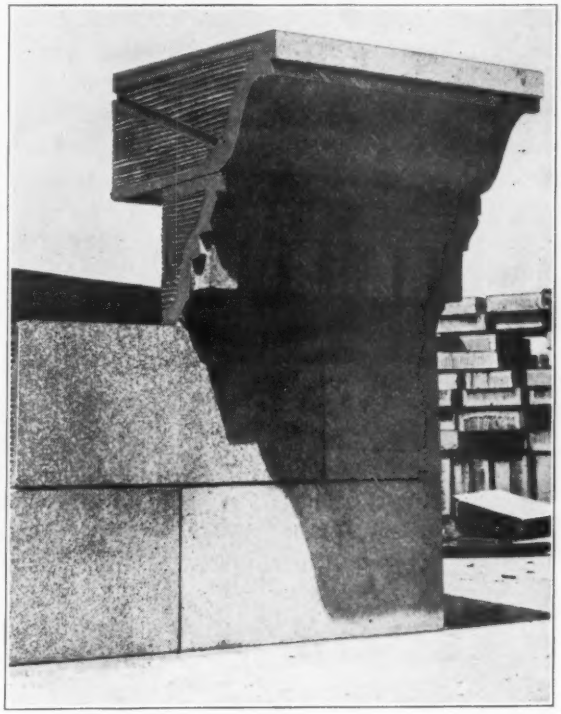


FIG. 10.—Terra cotta construction on Union County Court House, showing seepage bar for water-seal joint, flush corrugated joint, and tuck-pointing lock.

field. They concern dishonest or incompetent workmanship which is controllable by those entrusted with or responsible for such supervision.

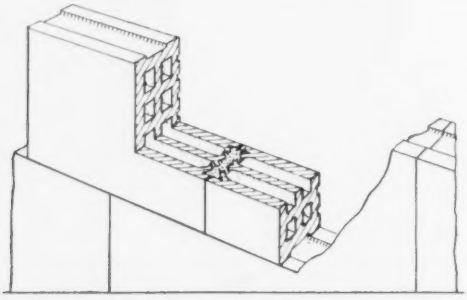


FIG. 11.—Machine-made terra cotta ashlar block laid with economy of brick; shows interlocking mortar clinch end joints.

Items 3 and 4 are problems of utilitarian design. Mortar joints are a major element in construction, are intended to serve *a distinct structural purpose, and should be fundamentally so treated. They should not* first be considered as an element of architectual design to the extent of being even slightly defective in weathering quality, nor should they be increased or decreased in size or form, with utility (resistance to moisture) a secondary matter.

The solution of the problem is of major importance to all manufacturers of exterior building materials, and the subject is obviously one which can and should be gone into in far more detail than permitted by the space given here.

FEDERAL SEABOARD TERRA COTTA CORPORATION
10 EAST 40TH STREET
NEW YORK, N. Y.

REASONS FOR THE USE OF AUXILIARY FLUXES IN WHITEWARE BODIES*

BY ARTHUR S. WATTS

I. Introduction

Glass Phase in Porcelain

The study of auxiliary fluxes for whiteware bodies has increasingly emphasized the necessity for more detailed information regarding the glassy phase of ceramic bodies. Microscopic study of a normal whiteware body underfired, normally fired, and overfired discloses a gradual development of glass due to the solution by the feldspar of small amounts of clay and flint. The principal change noted is the increasing fluidity of the feldspar enabling it to envelop more completely the particles of other minerals present.

In spite of the higher silica and higher alkali content of the ball clays, their substitution for china clay does not apparently increase the amount of glass developed and certainly does not increase the translucency of the body, even though the degree of vitrification as indicated by water absorption may be increased.

The introduction of small amounts of CaO and MgO increases materially the amount of glass formed in a normal whiteware body and also increases the translucency, but the maturing temperature is appreciably lowered.

The fluidity of the glass phase existing in feldspar plus CaO and MgO is materially increased and the clay and flint particles are more completely enveloped in the glass. This is accompanied by a slightly increased solution of the clay and fluid particles. If the amounts of CaO and MgO are increased the maturing temperature may be somewhat lowered but with increasing tendency to distortion, and a ratio between the feldspar and auxiliary fluxes is reached beyond which a stony structure develops and no increase in translucency is noted.

Object of Frit

The object of the artificial auxiliary flux or frit is to provide increase in translucency and decrease in maturing temperature without increasing the tendency to distortion. The use of a small amount of some low fusing glass was attempted with the idea that the frit would become viscous through being saturated with Al_2O_3 and SiO_2 before the temperature was reached at which the feldspar component became active. This was only moderately successful, because the glass or frit reacted with the feldspar, reducing its viscosity and causing distortion before the feldspar could exert its normal vitrifying action. Thus no advantage was gained over the use of the feldspar alone except for the slightly lowered maturing temperature of the body, which would hardly justify the introduction of an artificially prepared flux.

II. Requirement of the Glass

The solution of the problem lies apparently in

* Presented at the Annual Meeting, American Ceramic Society, Cincinnati, Ohio, February, 1934 (White Wares Division). Received February 15, 1934.

the development of a glass which (1) will maintain a relatively constant viscosity through solution of Al_2O_3 and SiO_2 at the rate of temperature increase normal to whiteware firing and (2) is not seriously active in decreasing the viscosity of the feldspar when the temperature of its activity is reached.

The first consideration calls for a study of the influence of temperature on the viscosity of glasses of variable Al_2O_3 and SiO_2 content. This problem can be solved in part by using a glass of higher initial softening temperature, thus reducing the temperature interval through which a viscosity reduction could take place. If increase in initial softening temperature is accomplished through higher Al_2O_3 and SiO_2 content the water solubility of the glass will be notably decreased, and one criticism of the type of glasses studied heretofore will be eliminated.

The second consideration calls for a study of the influence of various glasses on the viscosity of normal feldspar. Phase-rule data now available may furnish some suggestions but little definite information on this subject.

Some preliminary work in the field of $KNaO$–Al_2O_3–SiO_2 glasses as auxiliary fluxes to potash feldspar shows promise, the fusion temperature of the feldspar being greatly reduced without serious loss of viscosity. The physical properties of these glasses are now being determined.

A frit of the following composition

$$\left.\begin{matrix} 0.25\ K_2O \\ 0.35\ Na_2O \\ 0.25\ CaO \\ 0.05\ MgO \\ 0.10\ BaO \end{matrix}\right\} 0.35\ Al_2O_3 \left\{\begin{matrix} 5.0\ SiO_2 \\ \\ 0.5\ B_2O_3 \end{matrix}\right.$$

has also been produced and tested and shows promise. It was digested in both water and 3% HCl at 180°F for 90 days without any solution. It matures, however, at cone 3 which is lower than is needed and, if made more refractory, it must be prepared by sagger fritting. This is contemplated.

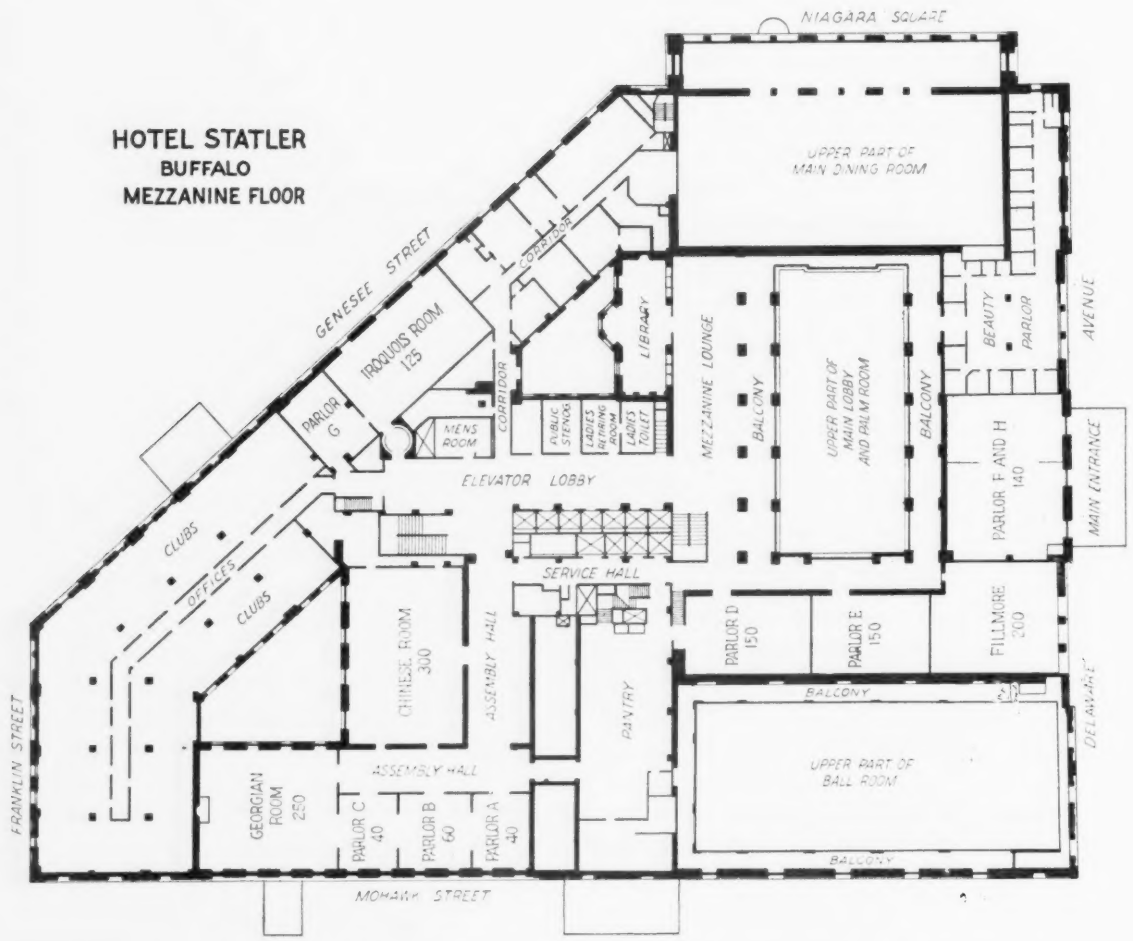
A significant parallel to these observations is found in some of the early Belleek bodies which employed, as auxiliary flux, calcined feldspar, a frit of feldspar plus K_2CO_3, and a small amount of potash-lime glass.

Department of Ceramic Engineering
The Ohio State University
Columbus, Ohio

ACTIVITIES OF THE SOCIETY

Officers of the Industrial Divisions

L. E. Barringer Charles Harder	Art	R. C. Meeker H. B. DuBois	Materials and Equipment	J. L. Carruthers D. A. Moulton	Structural Clay Products
W. N. Harrison B. J. Sweo	Enamel	H. E. White R. E. Birch	Refractories	R. F. Grady, Jr. H. E. Davis	Terra Cotta
James Bailey F. C. Flint	Glass			Edward Schramm T. A. Klinefelter	White Wares



"SHUFFLE OFF TO BUFFALO"

During the week of February 17, 1935, the American Ceramic Society will hold its 37th Annual Meeting in Hotel Statler, Buffalo, N. Y. The commodious and convenient meeting room facilities are shown in this illustration, all on the mezzanine floor. In addition there are the Ball Room on the lobby floor and the large Terrace Room one floor below the lobby, both of which are available for meetings and social events.

The Local Committee is organized and ready to make our 37th Annual Meeting memorable, not alone for the technical meetings and public lectures but also for the plant trips and social events. They intend that we shall shuffle while in Buffalo.

The Executive Committee of the 1935 Meeting is as follows:

M. E. Holmes, *General Chairman*
S. F. Walton, *Vice-Chairman*
L. D. Walrath, *Finance*
F. D. Bowman, *Publicity*
Donald Sharp, *Transportation*
R. C. Benner, *Plant Trips*
S. F. Walton, *Entertainment*
Mr. and Mrs. W. E. Bown,
M. E. Holmes, *Exhibition.*

SYMPOSIUM ON KILN FIRING PROPOSED

This symposium has been suggested for Monday afternoon, February 18, 1935, at the Annual Meeting of the American Ceramic Society in Hotel Statler, Buffalo, New York, under the auspices of the Materials and Equipment Division.

The challenge is that kilns can not be fired uniformly by convection alone, using surface combustion gas burners, electric heating elements, highly aërated oil burners, or complete combustion of coal on the grates. This is contrary to statements made by several persons who are reputed to have made studies of kiln firing.

This promises to be a lively symposium and will profit ceramic manufacturers greatly because the firing of their products is a large item of expense, and on the firing depends the quality of the ware.

Correspondence on this topic has already started. Excerpts from two of the letters follow:

From Eugene D. Milener, Industrial Research Representative, American Gas Association

Your letter of April 13 to V. V. Kelsey of Trenton, N. J., indicates that the ceramic industry is keenly interested in better kiln construction and better firing.

The subject of kilns and kiln firing has received considerable study by the Committee on Industrial Gas Research during the last five years, and you may be interested in some comments on the Research Committee's analysis of these subjects and the research work which it has sponsored in order that better heating processes and more efficient equipment be made available to the ceramic industry through the use of gas. For instance, regarding your statement

> At no time has there been a challenge issued against the use of updraft beehive kilns, once so extensively used by potters, in which it is impossible to get even distribution of heat or economical use of fuel. In no place have I seen statements of why muffle kilns, such as are used by terra cotta manufacturers, are wholly inadequate for the purpose because of the impossibility of getting even heat distribution.

Your remarks contain some of the essence of the original analysis of this subject made by our Research Committee.

Since 1929 the Committee has emphasized the elimination of muffles in ceramic kilns. For instance, in the 1929 report, it is stated that once the fundamental facts were known, we would be in a position to attempt to develop processes for the direct firing of ceramic ware, something now impossible in most of the ceramic classifications. The 1930 report says

> The entire technique of most ceramic firing with gas has been built up around the use of indirect heating. This has retarded the introduction of gas into many ceramic factories as an excessive amount of fuel is required to force the heat through a muffle.

For nearly four years the Research Committee maintained a fellowship at the Department of Ceramics, Rutgers University, and after three years we felt that the fundamentals were sufficiently well known to attempt to apply direct firing under practical conditions. The first attempt was with glost firing of whiteware, to be followed by bisque firing, decorating, etc. Two years ago we selected the Lenox plant where the utmost in accuracy of firing would be required and where any defects in the resulting ware would be noted quickly. Elimination of muffles by direct firing and an absolutely uniform distribution of heat have been attained. A 65-foot kiln was used (which we believe is far shorter than any previously used in the industry). Reduction of time cycle to twenty-four hours in and out, the substitution of walking beams in place of the cumbersome cars (the first walking beam as far as we know to be used in the ceramic industry and the first walking beam to be used in any industry above 2000°), and a substantial reduction in the overall cost for firing were added advantages.

We believe that all of these steps have been challenges against the use of updraft beehive kilns and that, although up to this time the results have been demonstrated on a full-size scale only in connection with glost, as the work progresses advantages will be apparent to those interested in many other branches of ceramic firing.

You state that no more erroneous statement could be made by the Bureau of Mines than that the combustion of gases from the fuel bed is very rapid and, under normal conditions, is completed within a few feet of the fuel bed and that heat from the fire box is carried to the ware in the kiln by convection, by hot gases, and by radiation from incandescent particles of carbon and fly ash. I do not know to what extent the Bureau emphasized the importance of the radiation from particles of carbon and fly ash, but I do believe that it was absolutely right in stating that convected heat is a sound method for conveying heat to the ware in a kiln evenly and cheaply because of the elimination of muffles. In the Lenox plant we are throwing away the limitations which muffles have placed on ceramic firing and the limitations of radiated heat and we have substituted convected heat which has the ability to carry heat evenly and uniformly to every nook and cranny of the ware being heated. We believe that by this method uniformities heretofore unattainable can be regularly secured and that the B.t.u.'s will be considerably less per ton of ware fired than when muffles are introduced in the kiln.

This laboratory and field work has been closely followed by men connected with different potteries and as each step has been taken their advice has been sought. I do not know just why you consider it important to stop the expenditures on the part of fuel companies who are seeking to overcome the very limitations of kiln construction and kiln firing which you state are in need of improvement. The Gas Association believes that the money it has spent in this field has been well spent and from statements that have been made by a number of potters, we are led to believe that it is their opinion that the work has been constructive and will have an increasingly important influence on kiln design and firing in the future.

It seems strange that it is considered by you nothing short of a crime that we have not shown reason for a protest and developed an educational program against the activities of the so-called experts in oil, gas, and electric heating means proposed for firing ceramic kilns.

As the reports of our Research Committee show, we enter a great many industries on a similar basis, and our technical contributions have been well received.

We have said comparatively little about the work we have done in direct firing ceramic ware; rather we have preferred to wait until tangible results were secured. We believe the results are now quite tangible.

I hope that you will pardon my commenting on your letter so frankly, but I hesitate not doing so because of the splendid coöperation we have received from the members of the ceramic industry in the Trenton district. We have been encouraged at every step by those members of the ceramic industry whose counsel we have sought, and we greatly appreciate their substantial contributions of time, samples, plant facilities, apparatus, and equipment.

From Ross C. Purdy to Eugene D. Milener, Industrial Research Representative, American Gas Association

I am pleased to note the thorough manner in which the Committee on Industrial Research has studied the industrial possibilities of gas for the firing of clay, glass, and porcelain enamels.

In Zanesville, Ohio, in 1899, we fired ceramic kilns under controlled gas pressure. No alterations were made in kiln construction or in the setting of the ware when gas was first used. The amount of air entering the simple burners used was controlled by closing the vents. Ware that ranged in required heat treatment from cone 8 to cone 4 was successfully fired, although it was difficult to get the bottom of the kiln up to cone 4 because all of the air required for combustion came through the burners. This set-up was inadequate for firing full kilns of cone 8 or cone 4 ware alone. Under these circumstances the kiln firing was turned over to me, and I first tried to get complete combustion of the gas within the fire box and bag wall and, by management of the draft, secure equal heat distribution; this set-up was all wrong.

I sought opinions from engineers at Ohio State University, experienced ceramic plant operators, and practical kiln firemen. Finally I was advised to pipe the gas into the fire box with a $^3/_4$- or 1-inch pipe having on the end a cap in which a small aperture was bored. Over this pipe we placed a shorter length of 2-inch pipe which we could adjust to vary the amount of air introduced for primary combustion at the burners and in the fire box. We loosened up the brickwork in the fire door and left a space around the burners through which secondary air could enter. A hole in the kiln wall was opened above the hub leading into the kiln bag wall. This opening was controlled by sliding a loose fire brick over the hole. To our amazement with this crude equipment cone 8 or cone 4 was obtained under oxidizing conditions throughout the kiln.

This experience completely contradicted the theories instilled in me regarding kiln firing. For a few years I still attempted the firing of small kilns in university laboratories with coal on grate bars, securing all of the air for combustion through grates rather than as secondary, always with uneven kiln firing regardless of the size or construction of the kiln.

Later I was made responsible for the control of the firing of Lawton type kilns ranging from 5 to 22 feet in diameter. Recording pyrometers were installed and cones and Veritas firing rings were used liberally throughout the setting for observation. Anthracite and, later, run-of-mine bituminous coal were used. These kilns had to be fired absolutely uniform throughout at cone 11. Recalling my experience with gas firing in Zanesville, I began to use liberal quantities of secondary air and restricted the amount of primary air through the grate bars. We were successful in firing under oxidizing conditions with absolutely uniform heat distribution, as shown by the exposed and hidden pyrometric cones and by the Veritas shrinkage rings scattered throughout the kilns.

For twenty years I have studied methods of kiln firing and kiln construction and have followed closely the efforts to develop electrically heated furnaces and kilns, as well as the use of oil and all coals. I have had experience with premixer gas and intricate burners designed for firing large furnaces such as kilns and several times I have disconnected the premixer and put in simple burners with a means for proportioning the secondary and primary air. In all these experiences I have used the lesson learned in Zanesville in 1899 and have been successful in getting equal heat distribution under oxidizing conditions throughout the kiln.

With gas and oil no solid matter was deposited on the ware. There was a small amount of fly ash from anthracite coal and more from the soft coals but not much from either. Stoneware kilns have been fired with soft coal with the glazed ware unprotected by saggers with no damaging amount of fly ash on the ware.

I have always used very little draft, and have taken induced draft out of some kilns. The draft used is not enough to cause much fly ash, and depends upon the rate of heating desired.

My use of secondary air, thereby obtaining diffusion flame combustion, gives control of the rate of heating and equal distribution of heat treatment throughout the kiln.

The Committee on Industrial Gas Research in its fifth Annual Report, June, 1931, on pages 17, 19, and 21, disclosed a more scientific and complete understanding of my method of firing kilns than I have seen elsewhere. It was far more expertly stated than I have at any time had in mind. By experience, without giving it much study, I have come to the same conclusions as set forth in this Committee's Report.

The reports of this Committee from 1929 to 1933 show an intensive study of ceramic kiln requirements. They do not, however, disclose the fact that ceramic kilns have been successfully fired with gas for nearly four decades.

Before the tunnel kiln, ceramic ware had to be stacked in saggers in large kilns. With coal firing the saggers were usually completely wadded to protect the ware from fly ash, but with gas firing only sufficient wads were used to keep the stands of the saggers solid and straight except for ware glazed with volatile materials which had to be kept from escaping.

In 1899 in Zanesville I successfully fired stoneware glazes and tile with fritted glazes in unglazed and un-

luted saggers, using gas as fuel. I would not have expected any difficulty with the usual fritted glaze or the more refractory glazes used on porcelain sanitary ware and insulators.

It is my opinion, based on several years of experience and observation, that kilns can not be adequately heated by convection alone, *i.e.*, transfer of heat by means of current in the gases. This requires too rapid a movement of the gases. Convection plays an important part in tornadoes, thunder storms, and squalls, none of which we want in the kiln. In any method of firing there is convection, conduction, and radiation, but to obtain equal heat distribution in a large chamber such as a kiln, or even throughout a tunnel kiln car, more dependence must be placed on conduction and radiation which result from the combustion of gases within the kiln and around the ware. Only by extensive use of secondary air combustion can ceramic ware be given the equal heat treatment necessary to obtain and maintain uniform quality.

Standards for judging the quality of ceramic ware are becoming more strict. It is recognized that ware must be fired so as to obtain uniform thermal history throughout the ware and from piece to piece. This can not be obtained with electric heating or by surface combustion gas heating. To depend entirely on convection for transfer of heat from the fire box to the ware can not possibly give this equal thermal history to the ware in the kiln even on a single tunnel kiln car.

I hope that the Committee on Industrial Gas Research of the American Gas Association will collaborate with the American Ceramic Society in developing a worth while symposium on ceramic furnaces and kiln firing.

LOCAL SECTION NEWS

Baltimore-Washington Section Hears Dr. Brackett

On April 28, the Baltimore-Washington Section of the American Ceramic Society held a dinner meeting in Baltimore, Md. The group was addressed by Frederick Brackett of the Smithsonian Institution who spoke on "Color in Glass and Photochemical Deterioration."

CLARENCE HAHNER, *Secretary*

California Section Meets

The California Section of the American Ceramic Society was entertained in the Atheneum of the California Institute of Technology, May 21. Seventy members were present.

Rene Engel in charge of the Institute's Department of Mineralogy and Geochemistry, delivered a splendid paper on "The Geology and Clay Deposits of the Elsinore Region."

Dr. Engel's paper emphasized the fact that the fault system of this section of the country is the reason for the wide variety of valuable clays as well as the difficulty which has long been experienced in developing large bodies of these clays from prospects. The paper should prove to be of value to the large manufacturers who are dependent in considerable measure upon the Elsinore occurrences. The paper is the result of about five years' investigation by Dr. Engel and his assistants.

A paper by Robert T. Knapp of the Department of Mechanical Engineering on "Apparatus for the Recording of Size Distribution of Fine Particles" was of great interest in view of the growing recognition of the importance of particle-size distribution and control in the whiteware industry. Professor Knapp described the progress in the development of his apparatus which in its latest form gives a reproducible measurement of the particle-size distribution in silicate minerals of such a fineness that substantially all will pass a 200-mesh screen. The apparatus is so designed that a complete analysis of sizes ranging from 70 microns down to 10 microns can be obtained in a little more than an hour, during which time very little attention is required on the part of the operator.

The apparatus can be built in single units for small laboratories or in multiple units so that a number of samples may be run simultaneously where many such samples are required to be investigated over the twenty-four hour day.

While made for one of the Portland cement manufacturers, the machine has important applications in the ceramic industry and Prof. Knapp's contribution is worthy of recognition and investigation.

Unlisted speakers on the program were Dean A. C. Weatherhead, head of the College of Architecture and Fine Arts of the University of Southern California, who reported that the addition to the college buildings affording greater facilities to the Department of Ceramics has now been completed and is being equipped. Dean Weatherhead's work is being followed closely by the Local Section and as the Department develops progress reports will be made.

Robert Linton gave an impromptu account of his visit to the Annual Meeting in Cincinnati and conveyed the greetings of many ceramic engineers who had spent some time in California to their old friends.

T. S. CURTIS, *Secretary*

Chicago Section Active in Illinois

At a joint meeting of the Chicago Section of the American Ceramic Society and the Chicago District Enameler's Club held April 23, the Chicago Section elected the following officers for 1934: G. G. Hanson, Consolidated Feldspar Corp., president; George Arras, Quadrangle Mfg. Co., vice-president; and Herbert V. Kaeppel, *Ceramic Industry*, secretary-treasurer. C. W. Parmelee of the Department of Ceramics, University of Illinois, is to serve again as councillor to the Chicago Section for the coming year.

R. E. Brannan, sales engineer for the Bakelite Corp., spoke on plastics, their properties and uses.

Conference on Glass Problems Held June 1

Under the auspices of the Department of Ceramic Engineering, University of Illinois, and the Chicago Section of the American Ceramic Society the following papers were given at a conference on glass problems held in Urbana, Ill., June 1 and 2:

(1) "Observations on Some Important Properties of Glass House Refractories," by J. W. Wright, Owens-Illinois Glass Co., Alton, Ill.
(2) "Researches on Glass Conducted in the Department of Ceramic Engineering," by C. W. Parmelee, Urbana, Ill.
(3) "Production of Glass Wool as a Problem in Glass Technology," by C. F. Freyling, State Geological Survey, Urbana, Ill.
(4) Demonstration of the preparation of glass wool, by C. F. Freyling.
(5) Lecture and demonstration, "High Vacua Electrical Discharge Phenomena," by C. T. Knipp.
(6) "Benefits of the Use of Alumina in Commercial Glass," by Robert Ferguson, Pittsburgh, Pa.
(7) "Surface Tension of Molten Glass by the Dipping Method," by R. G. Hunter, Owens-Illinois Glass Co., Alton, Ill.
(8) "Surface Tension of Molten Glass by the Jaeger Method," by C. W. Parmelee and K. C. Lyon, Urbana, Ill.
(9) "Specific Heat of Molten Glass," by A. E. Badger, Urbana, Ill.

Pacific Northwest Section Elects New Officers

The 13th annual meeting of the Pacific Northwest Section was held at the University of Washington, Seattle, on May 5. Dinner at the University Commons was followed by a short business session. The following officers were elected: *President*, H. R. Kreitzer, Columbia Brick Co., Portland, Ore.; *Vice-President*, James G. Adderson, Gladding, McBean & Co., Taylor, Wash.; *Secretary*, Hewitt Wilson, University of Washington; *Councillor*, Dean Milnor Roberts, College of Mines, University of Washington; and *Treasurer*, H. O. Thompson, Builders' Brick Co., Seattle.

HEWITT WILSON, *Secretary*

Pittsburgh Section Hears A. Nadai

The Pittsburgh Section had, as speaker at the April 8 meeting, A. Nadai of the Westinghouse Research Laboratory. Dr. Nadai, a native of Hungary, received his degrees at the University of Zürich, Technische Hochschule, Berlin, and the University of Pittsburgh. Dr. Nadai's numerous publications in both German and English include several books, the best known of which are Elastische Platten, published in 1925, and Plasticity published in 1931 (*Ceram. Abs.*, **11** [2], 139 (1932)).

Dr. Nadai illustrated evidence of plastic deformation in solids by slip lines in polished steel specimens under stress. The same type of slip lines found in laboratory specimens are observed in geological formations.

The next meeting of the Pittsburgh Section will be held at State College, Pa., in October. Further details will be announced later.

RESOLUTIONS

American Ceramic Society Urges Adequate Support for the Bureau of Standards

The Executive Committee of the Board of Trustees, American Ceramic Society, passed the following resolutions at a meeting in Buffalo, New York, May 4:

WHEREAS the American Ceramic Society was one of the organizations influential in the establishment of the Bureau of Standards in 1901; and

WHEREAS the American Ceramic Society has continued its support and its encouragement of the Bureau's activities, especially in the field of fundamental and scientific research; and

WHEREAS, as a consequence of the retrenchment policy of the Federal Government, the activities of the Bureau of Standards have been drastically curtailed to the serious detriment of the science and technology of ceramics and of the several ceramic industries; therefore

BE IT RESOLVED that the attention of the proper committees and members of Congress be called to this critical situation, and that they be requested when making appropriations for the coming fiscal year to provide adequately for (*a*) fundamental research at the Bureau of Standards; (*b*) the maintenance of units and standards of measurement; and (*c*) research and development in the science of measurement—all of which constitute the foundation stones of science, engineering, and the industrial arts.

THE AMERICAN CERAMIC SOCIETY
W. KEITH MCAFEE, *President.*

Summer Courses in Practical Pottery Offered by West Virginia University

During the first term of the Summer Session, June 18 to July 24, two courses in practical pottery will be offered in the Chemical Engineering Laboratories, Mechanical Hall.

The work in class 110s will consist of preparing the body mixes from the raw materials, shaping and firing the ware, glazing and again firing the glazed ware, and applying decorations. Instruction will be given in shaping the ware by hand modeling, jiggering, throwing on the potter's wheel, and casting. The class will meet daily except Saturday, 9 to 12 A.M., and will carry two hours' credit.

The work in class 111s will be primarily for those who have completed the work in 110s or who have had equivalent work, but may also be taken concurrently with 110s. This course will deal largely with the preparation and application of glazes and colors. The class will meet daily except Saturday, 2 to 5 P.M., and will carry two hours' credit.

If teaching time permits in the clay shop, students may be admitted to take the work without credit, putting in such regular time as their schedules will permit.

The lecture and recitation work will be given by W. A. Koehler. Thomas Parker will give instruction in practical work in the clay shop.

No special fee is charged for the courses, but students taking the work must be registered for the first term of the Summer Session. Registration day is June 18.

Facilities in the clay shop will take care of only a limited number of students. Those desiring particularly to take the courses are requested to write to W. A. KOEHLER, Dept. of Chemical Engineering, West Virginia University, Morgantown, W. Va.

NEW MEMBERS

CORPORATION

Crooksville China Co., Guy E. Crooks (voter), Crooksville, Ohio.

PERSONAL

Arrandale, Roy S., 507 W. Morrell St., Streator, Ill.
Baldauf, Harold G., 210 East 19th St., Anderson, Ind.; Assistant Factory Superintendent, National Tile Co., Inc.
Conover, Ray C., 7332 Lafayette Ave., Chicago, Ill.; Harbison-Walker Refractories Co.
Garson, Francis J., Secretary and Superintendent, New Jersey Porcelain Co., Pennsylvania Ave. and Plum St., Trenton, N. J.
Hood, Harrison P., 83 East 4th St., Corning, N. Y.

Leaver, Stanley, Carborundum Co., Niagara Falls, N. Y.
Palmer, Willard E., 345 Indiana Ave., Chester, W. Va.; Taylor, Smith & Taylor Co.
Riebel, E. D., Y. M. C. A., Dayton, Ohio; Frigidaire Corp.
Shelton, Stephen M., 151 Industrial Bldg., Bureau of Standards, Washington, D. C.
Strubler, Gordon L., Research Dept., Chicago Bridge & Iron Works, 1305 W. 105th St., Chicago, Ill.
Turner, Arthur A., 25 Cliffwood Place, Metuchen, N. J.; Sales Engineer, Refractories Division, Carborundum Co., Perth Amboy, N. J.
Winship, William W., 58 Schenectady Ave., Brooklyn, N. Y.; Manager, Thermal Syndicate, Ltd.

STUDENT

Duvall, Wayne H., University of Illinois.

Membership Renewals

Irish Glass Bottle Co., Ltd., W. R. Duthie (voter), Charlotte Quay, Dublin, Ireland.
National Fireproofing Corp., R. A. Shipley (voter), 1134 Fulton Bldg., Pittsburgh, Pa.

Membership Workers' Record

PERSONAL		CORPORATION	
A. I. Andrews	1	Office	1
E. E. Baldauf	1		
C. F. Geiger	1	STUDENT	
W. N. Harrison	1		
P. D. Helser	1	K. C. Lyon	1
W. Horak	1		
E. H. Lintz	1		
J. R. Smith	1		
W. C. Taylor	1		
Office	3		
Total	12	Grand Total	14

ROSTER CHANGES

CORPORATION

West Gas Improvement Co., Inc., S. J. Beale (voter), 424 Madison Ave., New York, N. Y. (441 Lexington Ave., New York, N. Y.)

PERSONAL

Austin, Chester R., Battelle Memorial Institute, 505 King Ave., Columbus, Ohio. (1123 Stewart Ave., Cambridge, Ohio.)
Boehler, Joseph, 4643 Monroe, Austin Sta., Chicago, Ill. (Ohio State University.)
Callahan, H. D., Sparta Ceramic Co., East Sparta, Ohio. (Columbus, Ohio.)
Callinan, J. Gavin, 126 Oak St., Clarksburg, W. Va. (484 St. Clair Ave., Columbus, Ohio.)
Donnenwirth, A. L., 3915 DeVeaux St., Niagara Falls, N. Y. (Brooksville, Pa.)
Edwards, F. Moorland, Robinson Clay Products, Akron, Ohio. (74 E. Lane Ave., Columbus, Ohio.)
Ellinger, H. Clay, 958 Islington St., Toledo, Ohio. (Thornville, Ohio.)
Falknor, Tom, 126 W. Tulane Rd., Apt. A., Columbus, Ohio. (Trenton, N. J.)
Hart, Karl, 7022 Staford Ave., Huntington Park, Calif. (Vitrefrax Co., Ogilby, Calif.)
Hartford, Frank M., Allied Engineering Co., 4150 E. 56th St., Cleveland, Ohio. (87 W. Main St., Columbus, Ohio.)
Hoffman, C. A., Walsh Refractories Corp., Vandalia, Mo. (British Ceramic Service Co., Ltd., Glasgow C-2, Scotland.)
Hutchison, R. C., Hotel Kenmar, Mount Union, Pa. (Armagh, Pa.)
Johnson, H. E., 4616 Lindell Blvd., St. Louis, Mo. (Johns-Manville, Manville, N. J.)
Kleerup, Alex, 75 E. Wacker Drive, Chicago, Ill. (Western Asbestos Magnesia Co., San Francisco, Calif.)
Lee, H. C., 124 W. Oakland Ave., Columbus, Ohio. (Dolomite Products Co., Maple Grove, Ohio.)
Maize, R. S., Third St., California, Pa. (Pennsylvania State College.)
Malsch, Werner, 402 6th Ave., Belmar, N. J. (1611 Michigan Ave., Miami Beach, Fla.)
Miller, John B., 3440 Superior Park Drive, Cleveland Heights, Ohio. (4120 Washington St., Niagara Falls, N. Y.)
Ogale, G. P., P. O. Ogalevadi, Dist. (Satara), Bombay Presidency, India. (P. O. Jorawarnagar, India.)
Paul, Austin J., 4963 Winona, St. Louis, Mo. (608 W. 10th St., Rolla, Mo.)
Rhode, Irma, 3836 W. Pine Blvd., St. Louis, Mo. (Charlottenburg, Germany.)
Robson, James T., Allied Engineering Co., 4150 E. 56th St., Cleveland, Ohio. (87 W. Main St., Columbus, Ohio.)
Rossell, H. A., Christmas, Ariz. (1710 Byers Ave., Joplin, Mo.)
Schotts, Walter H., 55 W. Starr Ave., Columbus, Ohio. (215 Estudillo Ave., San Leandro, Calif.)
Stephenson, H. H., c/o General P. O., Sydney, Australia. (Christchurch, New Zealand.)
Stong, Guy E., Corning Glass Works, Corning, N. Y. (Iowa State College.)
Suter, Walter P., New York Ceramic Studios, 114 E. 56th St., New York, N. Y. (21 Kenmare Rd., Larchmont, N. Y.)
Sylvester, George R., Allied Engineering Co., 4150 E. 56th St., Cleveland, Ohio. (87 W. Main St., Columbus, Ohio.)
Thiemecke, Harry W., Homer Laughlin China Co., Newell, W. Va. (Derry, Pa.)
Trevathan, P. Edward, Templeton, Pa. (Rocky Mount, N. C.)

LETTERS TO THE EDITOR

Ceramic Education

. . . I have noted your editorials on ceramic education and wish to commend you most vigorously. The unexplored areas are relatively larger in the field of ceramic science and new knowledge must come through emphasis in education along the lines that you have advocated. . .

April 27, 1934. F. K. PENCE[1]

Ceramic Education in North Carolina

Your editorial in the May *Bulletin* was much enjoyed. I do not agree with you in all respects but on the whole it is a concise, conservative statement. I can not see eye to eye with you in statement No. 7 in the first paragraph. I am going to "dilute" any curriculum with which I have anything to do with some business or economics and plenty of other things that you would throw out and, thank God, I have a president and faculty that believe as I do.

My reason for writing this letter is to tell you that in the matter of the items enumerated in your fourth paragraph this department stands as follows: (1) We have studied the recommendations made at the 1933 meeting and adopted them to the extent we thought necessary or possible and have offered an option in technology in order to better meet the needs of men requiring more science for certain lines of work. (2) We have increased the cred-

[1] F. K. Pence Tile Works, Paducah, Ky.

its in so-called cultural subjects including economics, but not at the expense of science subjects. (3) We have increased the total credits in mathematics, physics, and chemistry. (4) We believe mathematics should be taught by mathematics specialists whether engineers or not, and our students are so taught. (5) We believe chemistry should be taught by chemistry specialists and our students are so taught. We are unalterably opposed to instructors in such departments as ceramics teaching anything but their own specialty and have successfully fought other departments here that attempt to do it.

(6) We do not look on "Occurrence and Properties of Clays" or as we call it, 'Ceramic Materials," because we try to broaden the field, as a geology subject. Geologists, even of the Ries type, can not teach this course because I want to make it fundamental to all other courses in this department. Properly taught one can lay the foundation for all other ceramic courses. We devote only three credits to it and it follows and ties in with the first course in geology.

One other comment. My idea of the function of a college agrees with that of Roberts. My one aim is to teach students to think and to be self-reliant. I work at it from the time they enter as freshmen. It's a tough job with some, probably the majority, simply because I contact them so little during their four years here and there are too many instructors who teach on the "memory" theory who constantly tear down as I build up.

I have consistently attempted to stay clear of so-called practical courses and from teaching "practice." I do very often attempt to show the application of theory to practice. Like you, I believe the teaching of "practical" courses lowers college instruction to a trade-school level. My experience has shown me, however, that you must teach a certain amount of "applied science" in order to make the pure science of value to an engineer.

May 29, 1934. A. F. GREAVES-WALKER[2]

[2] Professor of Ceramic Engineering, North Carolina State College of Agriculture and Engineering of the University of North Carolina, Raleigh, N. C.

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NECROLOGY

ARTHUR D. FORST

Founder and, for forty years, president of the Robertson Art Tile Co., Trenton, N. J., Arthur D. Forst passed away on April 2. Mr. Forst received his early education in Trenton, and at the age of eleven went to New York to attend the Columbia Grammar School. He later entered Princeton University and was graduated with the class of 1888. In 1890 he became associated with the Robertson Art Tile Co. and later became its president. For some years he was president of the New Jersey State Hospital, Trenton, a director of the Y.M.C.A., a member of the board of managers of McKinley Hospital, and treasurer of the State Board of Park Commissioners.

NOTES AND NEWS

EDWARD ORTON, JR., CERAMIC FOUNDATION INAUGURATES RESEARCH

On January 1, 1934, the Standard Pyrometric Cone Co. and the Orton Memorial Laboratories were turned over to the Board of Trustees of the Edward Orton, Jr., Ceramic Foundation, but on request of the Probate Court, management was not assumed until May 1.

The Board of Trustees intends to maintain the high quality product associated with the Orton name for thirty-five years and to improve the product in keeping with recent theory and practice. On May 1 the Trustees appointed G. A. Bole, ceramic research professor of Ohio State University, as manager and research director, with Myril C. Shaw as his assistant.

With the available facilities and personnel of Ohio State University, the trustees have inaugurated studies with a view to improving the pyrometric cones and maintaining their quality.

The personnel of the Board of Trustees and the appointment of Dr. Bole and Dr. Shaw guarantee a thorough search for all possible improvements in the quality of the Orton Standard Pyrometric Cones.

George W. Rightmire, President of Ohio State University, is president of the Board. Other members are E. A. Hitchcock, Dean of the College of Engineering and Director of the Engineering Experiment Station of Ohio State University; Arthur S. Watts, Chairman of the Department of Ceramic Engineering of Ohio State Uni-

versity; P. H. Bates, Director of the Ceramic Division of the National Bureau of Standards; John M. McKinley, Vice-President and Director of Research of the North American Refractories Co.; Ross C. Purdy, Secretary of the American Ceramic Society; and Simeon Nash, attorney. Four members of the board have an intimate acquaintance with the use of ceramic pyrometric cones. Mr. Purdy and Professor Watts had years of experience with General Orton in the manufacture of the cones.

No change will be permitted in the deformation temperature of the cones, but all processes will be standardized and control tests inaugurated which will greatly increase the value of the cones as accurate standards. Researches based on complete knowledge of pyrometric cones and their use under various conditions of service have been inaugurated.

Information obtained will be made available as rapidly as possible to users of cones. Graduate research fellows will conduct these researches under the direction of Dr. Bole and a council of advisers selected from the particular ceramic industry concerned. Appointment of the fellows will be made from all fields of science and engineering.

NEWS OF MEMBERS

Clyde E. Williams Appointed Director of Battelle Memorial Institute

With news of an expansion program at Battelle comes the announcement of the appointment of Clyde E. Williams as Director of the Institute and H. W. Gillett as chief technical adviser. A greater range of research and development work within the Institute has been planned and many new projects of outside sponsorship have been accepted.

Both Dr. Gillett and Mr. Williams have been associated with the Institute since 1929, Dr. Gillett as director, and Mr. Williams as associate director and metallurgical supervisor.

A. F. Greaves-Walker Is Honored

A. F. Greaves-Walker, head of the Department of Ceramic Engineering at the Raleigh unit of the University of North Carolina has been elected president of the North Carolina chapter of Phi Kappa Phi, national scholarship honorary fraternity. This organization is the Phi Beta Kappa of the technical schools of the country and has sixty chapters.

At the first meeting over which Professor Greaves-Walker presided he had the pleasure of seeing every member of the senior class in ceramic engineering elected to membership in the fraternity.

Edgar Littlefield Pottery Awarded First Prize*

First prize of $50 for pottery exhibited at the National Ceramic Exhibition at the Syracuse Art Museum was awarded Edgar Littlefield of the Department of Fine Arts, Ohio State University.

The exhibit is held annually in memory of Adelaide Alsop Robineau, worker in porcelain who attained world-wide fame.

**Potters Herald*, May 10.

GEORGE V. McCAULEY DID IT†

The production of flawless glass disks for telescope mirrors has taxed the abilities of glassmakers here and abroad. The disk of a sixty-inch mirror must be eight inches thick and weigh one ton. The 100-inch mirror of the Hooker telescope at Mount Wilson, California, is thirteen inches thick and weighs nearly five tons. It is the largest in the world. The glass disk for the 200-inch mirror is nearly thirty inches thick and weighs approximately twenty tons. It is four times larger than the biggest mass of glass hitherto poured in a single mold.

George V. McCauley testing a sample of the glass prior to pouring the 200-inch disk at Corning Glass Works.

During almost six years of experiment experts studied the problem of casting the gigantic disk. Fused quartz proved too intractable for so large a mirror. Then came the idea of glass disks built up in segments with the edges fused together and the whole braced with ribs of polished metal. Composite disks were next tried by putting a glass coating on a metallic base, both the metal and the glass expanding and contracting the same with changes of temperature.

Finally the decision was made in favor of a single huge casting of a special low-expansion glass which was developed at the Corning Glass Works, Corning, N. Y. Experts worked out a new method of constructing the mold and an improved means of slow cooling for the process of annealing or hardening the glass. After two years of experimenting and when every detail of the project had been worked out, the day for the crucial pouring of the enormous mass of molten glass arrived.

Long-handled ladles, slung from overhead tracks, scooped up the white-hot glass and slowly moved it from tank to mold. Each ladle carried 750 pounds of the molten glass. After eleven hours' steady labor, the first stage in the production of the world's largest telescope mirror had been completed and, it was believed, with success.‡

If at the end of ten months, the disk comes from the mold whole and free from cracks and strains, it must be shipped to the optical shops of the California Institute of Technology, at Pasadena, where it will be ground and polished to an accuracy of within one-tenth of the wavelength of an average light beam. Because the heat generated by even fifteen minutes of polishing may

† Reprinted in part from an article by Kenneth M. Swezey, *Popular Sci.*, **124** [6], 13–15 (1934).

‡ For illustrations see *The Bulletin*, pp. 92–94 (April, 1934)

distort the surface of this optical giant, the polishing must be done in short periods, alternating with long intervals for cooling. On this account, completion of the task may require several years of painstaking effort.

JUNE MEETINGS

37th Annual Meeting of the A.S.T.M. to Be Held June 25 to 29

The American Society for Testing Materials will hold its 37th annual meeting at the Chalfonte-Haddon Hotel, Atlantic City, June 25 to 29.

Program items of special interest to ceramists are as follows:

Wednesday, June 27, 2 P.M.

The purpose of this session is to discuss certain aspects of the problems of specifying and controlling quality, particularly where quality can be measured only by sampling.

(1) "Acceptance-Rejection Requirements in Specifications," by H. F. Dodge, Bell Telephone Laboratories, Inc.—Mr. Dodge discusses the significance of certain simple criteria of acceptance and rejection that are often used in specifications. Quality characteristics for which it is feasible to make only a relatively small number of tests on a sampling basis are particularly referred to. The relationship between number of tests and certain risks associated with sampling is discussed.

(2) "Application of Statistical Methods to the Solution of Metallurgical Problems in the Steel Plant," by W. C. Chancellor, National Tube Co.—The desirability of considering plant metallurgical data on a statistical basis in efforts directed toward the production of uniform steel quality is emphasized, since the "exact relationships" governing are complex in their resultant effects and hence produce variable rather than "exact" results. Mr. Chancellor discusses and illustrates the application of a comparatively recent theory to the detection of assignable causes of variation. He stresses the use of rational subgroups of data rather than individual values, since the former can be more accurately treated by present theory. The construction and meaning of statistical control charts are discussed.

Wednesday, June 27, 4.30 P.M.

The purpose of the Edgar Marburg Lecture is to have described at annual meetings of the Society, by leaders in their respective fields, outstanding developments in the promotion of knowledge of engineering materials. Established as a means of emphasizing the importance of promoting knowledge of materials, the lecture honors and perpetuates the memory of Edgar Marburg, first secretary of the Society.

(3) Ninth Edgar Marburg Lecture: "Water as an Engineering and Industrial Material," by Sheppard T. Powell.—Dr. Powell reviews briefly the uses of water in engineering and industrial projects, drawing attention to the variety of specifications required to meet the varying demands for a satisfactory product. In this respect, he discusses not only the specific requirements in different industries but also certain recent advancements in the art of water purification to meet the critical requirements imposed upon the industry. The second portion of the lecture deals specifically with the problem of testing, more especially analytical procedure, to meet the exacting demands of present-day practice. It includes a brief survey of current research in this country and abroad, drawing attention to the potential value of petrographic, spectrographic, and other applications of analytical procedure.

Wednesday, June 27, 8.30 P.M.

(4) Annual Address by the President, T. R. Lawson.

(5) Award of Charles B. Dudley Medal.—The eighth award of the Charles B. Dudley Medal will be made to R. L. Templin, Chief Engineer of Tests, Aluminum Company of America, for his paper on "The Fatigue Properties of Light Metals and Alloys," which was presented before the Society at the 1933 annual meeting.

(6) Introduction of New Officers.

(7) Reception to New Officers and Members of Executive Committee.

Friday, June 29, 9.30 A.M.

(8) Report of Committee C-3 on Brick, by H. T. Shelley, Chairman.—The report recommends the adoption as standard of the tentative specifications for concrete building brick. Consideration is being given to the definition of brick, to modifications in tests for compression and transverse strength of brick, and to the inclusion of weather resistance requirements in clay building brick specifications.

(9) "Permeability Tests of 8-Inch Brick Wallettes," by L. A. Palmer and D. A. Parsons, National Bureau of Standards.—The properties of brick and mortar as related to the rate of water transmission through 240 test walls comprised of 5 different makes of brick and 10 different mortar compositions are discussed. These tests were carefully standardized and the data are of a quantitative nature and indicate definite means of improving brick masonry from the standpoint of water-tightness.

(10) "Tests on Reinforced Brick Masonry Columns," by M. O. Withey, University of Wisconsin.—Mr. Withey presents results of compression tests on thirty-two 12 by 12-in. reinforced brick masonry columns 6 or 12 ft. in length, including in the variables two types of brick, two mortar mixes, three percentages of longitudinal steel, and three percentages of lateral reinforcement. Data on the effects of several repetitions of load and of time of loading are given. Results show that strength of a reinforced brick masonry column is directly dependent upon the strength of the plain masonry, the strength at yield point of the longitudinal steel, and to a lesser degree upon the percentage of lateral reinforcement.

(11) "Resultant Separation Cracking between Various Mortars and Brick in Existing Brick Structures," by C. C. Connor, New Jersey Bell Telephone Co.—Results of linear measurements of separation cracks between the brick and mortar in about 40 brick buildings are presented. A percentage of separation cracks was obtained by measuring the cracks in various panels of brickwork at each building. Each panel contained the same linear footage of horizontal and vertical mortar joints and was selected to give a fair comparison.

(12) Report of Committee C-8 on Refractories, by R. A. Heindl, Chairman.—New tentative specifications for refractories used in incinerators and for ground fire clay are presented. Mr. Heindl recommends as tentative, new methods of chemical analysis of magnesite refractories, a general panel test for spalling, and a revised spalling test for boiler furnace brick. He proposes definitions for silica cement and for ground fire clay and recommends symbols for heat transmission of refractories. He presents revisions in the tentative method of test for high-temperature heat insulation and recommends the adoption as standard of the tentative method of test for particle size of ground refractory materials.

(13) "Effect of De-Airing Stiff-Mud and Dry-Press Bodies for Clay Products Manufacture," by W. C. Rueckel, Ohio State University, and R. B. Keplinger, Metropolitan Paving Brick Co.—A summary of the laboratory development and findings on de-airing of clay products and data relative to the improvement in properties of clay products obtained in commercial operation is presented. The authors describe the laboratory tests, placing particular emphasis on the improvement in fired properties (porosity, absorption, transverse and crushing strength, and modulus of elasticity).

(14) Report of Committee C-4 on Clay Pipe, by G. T. Hammond, Chairman.

CURRENT CERAMIC LITERATURE

New Abstracts of Silicate Literature (Referatkartei der Silikatliteratur)

According to information from Germany, the journal, *Feuerfest*, has ceased publication beginning with 1934. *Feuerfest* has been one of the few periodicals in the world devoted entirely to the subject of refractories.

To replace this publication, the Technical Bureau of L. Litinsky of Leipzig, Germany, is issuing a new journal, *Referatkartei der Silikatliteratur*.

These silicate abstracts are devoted to whiteware, structural clay products, refractories, cement and lime, glass, enamel, and allied fields, including raw materials, tests, standardization, etc. They will represent a review of the current world periodical literature devoted to silicates, *i.e.*, embracing about 100 periodicals containing yearly about 1200 to 1500 articles. (The number of cards for one year will apparently correspond to this figure.)

The silicate field will be divided into 25 groups as follows: (1) *General* (ceramics and the silicate industry in general; silicate systems and silicate melts, chemicophysical and mineral-chemical works). (2) *Silica Raw Materials* (quartz, quartzite, sand, sandstone, kieselguhr, etc.; geology, chemicophysical and thermal properties, etc.). (3) *Aluminosilicates* (clay, kaolin, diaspore, andalusite, corundum, bauxite, cyanite, etc.; geology and winning methods, chemicophysical properties, thermal behavior, etc.). (4) *Other Silicates* (feldspar, mica, pegmatite, asbestos, etc.). (5) *Different Raw Materials* (magnesite, dolomite, lime, fluorspar, chromite, zircon, graphite, rare earths, etc.). (6) *Preparation* (crushing, elutriation, sieving, grinding, etc.). (7) *Mass Preparation* (nonplastics, fluxing agents; mixing, dosage, weathering, kneading, etc.). (8) *Molding* (pressing, molding, models, etc.). (9) *Drying*. (10) *Firing* (heat economy, firing technique, gas producer, periodic and continuous firing furnaces, etc.). (11) *Porcelain, Earthenware, and Pottery* (utensils, insulators, sanitary ware, fired clayware, faience Dutch tile, wall tile, majolica, etc.). (12) *Stoneware and Structural Clay Products* (sewer pipe, clinker, floor tile, apparatus for the chemical industry, common red building brick, tile, drain pipe, paving brick, building terra cotta, etc.). (13) *Decoration* (glazing, engobe, coloring, and decoration). (14) *Refractories: Properties* (strength, chemical, thermal and electric resistance, porosity, gas permeability, thermal conductivity, structure, molding of chamotte, silica, sillimanite, magnesite, zirconia, chromite, and carbon refractories, special methods of manufacture). (15) *Refractories: Application* (requirements, behavior, and use of different refractories in the metallurgical, gas, glass, chemical, and ceramic industries, for boilers, etc.). (16) *Special Masses* (steatite, grinding materials, heat-insulating materials, molding sand for foundries, etc.). (17) *Cement and Lime* (Portland cement, blast-furnace cement, fused cement, limes, mortars, etc.). (18) *Gypsum and Artificial Stones* (Alabaster, sandstone, rhyolite, Sorel cement; manufacture, properties, and uses). (19) *Glass* (physicochemical foundations, preparation of batches, melting, molding, annealing, optical glass, hollow and pressed glass, plate glass, etc.; special glasses, quartz glass, water glass, glassmelting furnaces). (20) *Enamels* (technology, firing, etc.). (21) *Testing* (examination of raw materials and products; plant control). (22) *Plant Equipment* (machinery, transportation, plant erection, and exploitation). (23) *Education* (congresses, societies, exhibitions, etc.). (24) *Public Economy* (statistics, labor, trade, duties, taxes, freight, etc.). (25) *Miscellaneous* (historical, normalization, bibliography, etc.).

A few cards obtained from the editor indicate that they are of a standard size, 29.7 x 21 cm. The size of the abstract is not standardized and fluctuates from a quarter of a page to a page and a half. Subscription, Rm 27. Foreign, Rm 27.50. The cards are sent out at nearly regular monthly intervals. S. I. PERKAL

Silicosis Bibliography Issued June 10

Pneumonokoniosis (Silicosis)—Bibliography and Laws, compiled by George G. Davis, chief surgeon, Illinois Steel Co., Chicago; Ella M. Salmonsen, medical reference librarian, The John Crerar Library; and Joseph L. Earlywine, of the Illinois Bar, Chicago, will be off the press about June 10 according to the announcement of A. D. Cloud, of the Industrial Medicine Publishing Co. The price will be $6.00.

The bibliography covers the literature of the world from the first modern reference in 1556 to January 1, 1934. It is intended to serve as an exhaustive and comprehensive summary of all the references in the world's literature on "pneumonokoniosis (silicosis)."

A section of the book is devoted to laws concerning the occupational disease, the workmen's compensation, and the common law in the United States. The state laws are carefully and plainly abstracted, and in every case the abstract is followed by citations to all adjudicated cases.

Doctors, lawyers, industrial executives, insurance men, industrial boards, state commission officials, research workers, and others connected with an industry in which the inhalation of dust is an occupational risk will find the book valuable.

The 2768 references in the bibliography will be supplemented by further material in 1935. Inquiries should be addressed to Industrial Medicine Publishing Co., 844 Rush St., Chicago, Ill.

The Potter's Art Issued in De Luxe Edition

The Potter's Art by Cipriano Piccolpasso (1524–1579), published by the Victoria and Albert Museum, London, in an Imperial Quarto $10.00 edition is now available in this country.

ERRATA

On page 61 of *The Bulletin* for March, 1934, in the Report of the White Wares Division Standards Committee the authorship of the treatise, "Standardization of a Silicate Terminology" should have been credited to S. I. Perkal, Kharkov, U.S.S.R.

The chart of Official Personnel for 1934–1935 published in *The Bulletin* for May, page 134, should have listed N. W. Taylor as third member of the Refractories Division Papers and Program Committee. D. W. Ross is chairman of the Rules Committee of this division. G. J. Bair has resigned as chairman of the Data Committee; his vacancy is not yet filled.

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ALPHABETICAL LIST OF ADVERTISERS

	Page
Allied Engineering Co.	6
American Potash & Chemical Corp.	14
American Rolling Mill Co.	Inside Front Cover
Balfour, L. G., Co.	7
Buyers' Guide	8
Carborundum Co.	4
Ceramic Color & Chemical Mfg. Co.	6
Chicago Vitreous Enamel Product Co.	12
Classified Ad	6
Du Pont de Nemours, E. I., & Co., Inc.	Inside Back Cover
Edgar Bros. Co.	2
Edgar Plastic Kaolin Co.	2
Exolon Co.	14
Ferro Enamel Corp.	3
Hammill & Gillespie, Inc.	12
Journal of the Society of Glass Technology	2
McDanel Refractory Porcelain Co.	10
Metal & Thermit Corp.	Outside Back Cover
New York State College of Ceramics	6
Norton Co.	3
Pacific Coast Borax Co.	11
Paper Makers Importing Co.	7
Philadelphia Quartz Co.	3
Porcelain Enamel & Mfg. Co.	2
Potters Supply Co.	12
Professional Directory	10
Roessler & Hasslacher Chemical Co.	Inside Back Cover
Simplex Engineering Co.	5
Spinks, H. C., Clay Co.	14
Tables Annuelles de Constantes & Données Numériques	11
Wilson, H. W., Co.	11
Willson Products, Inc.	10

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The Experience

H. C. SPINKS CLAY COMPANY
NEWPORT, KY.

THREE ELEPHANT

AND BORIC ACID
GUARANTEED OVER 99.5% PURE
AMERICAN POTASH & CHEMICAL CORPORATION
70 Pine Street, New York

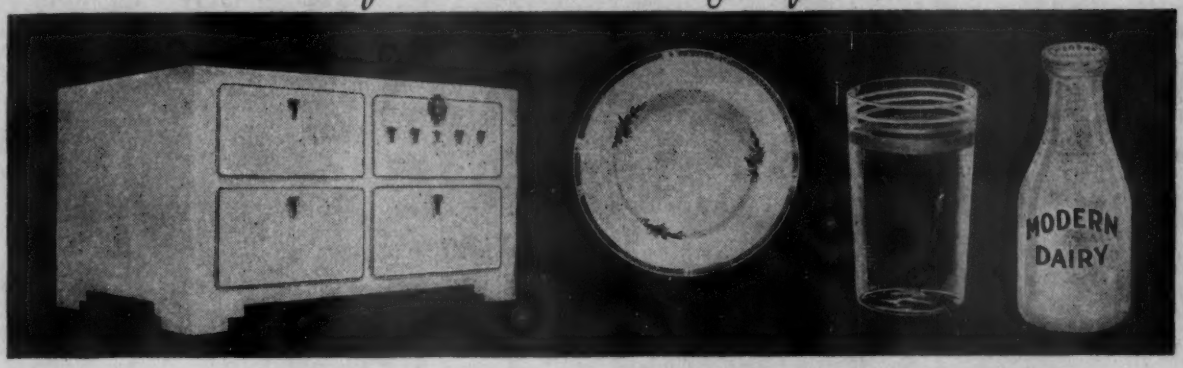
Refractory Materials
Products of the Electric Furnace

SILICON CARBIDE
ARTIFICIAL MULLITE
SILICON CARBIDE FIRESAND
FUSED ALUMINUM OXIDE
FUSED MAGNESITE

Furnished in raw material form, ground to meet specifications.
Our Research Department with fully equipped laboratories is always at your service.
WRITE US ABOUT YOUR PROBLEMS

THE EXOLON COMPANY
Established 1914
Electric Furnace Plant { THOROLD, ONTARIO
Finishing Plant / General Offices { BLASDELL, N. Y.

Sales-Making Decorations for you here . . . . .



because du Pont Pre-Tests color values here . . . .

Ceramic decorations don't make products *wear* better, but they do make them *sell* better. And since your profits depend on your sales, isn't it logical to select decorations of known quality, decorations which always give pleasing results, decorations which make your customers repeat with bigger orders?

"R & H" Ceramic Decorating Materials are all Pre-Tested at our plant for high color value before they are shipped. They *must* match standard colors and *must* give the same results as previous colors of the same grade. You can depend on these materials to give you decorated wares that *sell!*

Pre-Tested "R & H" Ceramic Decorating Materials comprise:

- **Precious Metal Decorations**
  For Dinnerware and Glassware
- **Glass Colors**
  For All Types of Glass Decorations
- **Body Slip and Glaze Stains**
  (Overglaze and Underglaze)
  For Pottery, Tile and Heavy Clay Products
- **Color Oxides**
  For Porcelain Enamels
- **Tin Oxide**
  A Trouble-Free Opacifier for General Use
- **Raw Materials**

Standardize on these "R & H" Materials for sales-making decorations. Write for full details and prices.

DU PONT
REG. U. S. PAT. OFF.

R&H Chemicals and Colors

The "R. & H." Chemicals Department
E. I. DU PONT DE NEMOURS & COMPANY, INC.
Ceramic Section: Perth Amboy, New Jersey

District Sales Offices: **Baltimore Boston Charlotte, N. C. Chicago Cleveland Kansas City Newark New York Philadelphia Pittsburgh San Francisco**

Du Pont also supplies a complete line of ceramic raw materials, including "Chemi-Trold" Feldspars and other minerals, chemicals and oxides.

M & T
Sodium Antimonate

For years M & T Sodium Antimonate has set the standard. The finest opacifier that modern methods can produce, it is always uniform, always pure. Every barrel of M & T Sodium Antimonate is exactly the same, both chemically and physically, as every other barrel.

And, this quality opacifier is more economical. Rejects, due to off colors, become rarities. Whites, whether blue white, cream white or some other hue, do not vary a shade from one year's end to the next where M & T Sodium Antimonate is used.

Our Ceramic Department will gladly help in solving your enameling problems. Homer F. Staley is manager; R. R. Danielson, director of research. Metal & Thermit Corporation, 120 Broadway, New York, N. Y.